Programme for Prosperity

ALTHOUGH the volume of new factory building has fallen over the past twelve months the current rate of construction is well above the 1955 figure. So far, therefore, the current change is not ominous for the rate could hardly be expected to increase continuously or to remain steady. With so many units and factors involved there is always bound to be some fluctuation.

Broadly speaking there are several factors which influence new factory building, and there are two distinct categories. The factors include the incidence of new invention, product development, the improvement of manufacturing processes, and the development of machine and plant design, all of which can be regarded as internal to industry by contrast with the body of external factors arising out of world trading conditions, social influences, and governmental policy. The two categories are simply those of privately owned enterprises on the one hand and the activities of government departments and nationalized industries on the other.

Although the whole of industry can be separated in this way there is a physical linkage throughout the whole which makes a change in any one part felt in other parts. Industry is like a reservoir which is large enough for the ripples from minor disturbances to disappear in a comparatively short distance, but which can be whipped up into large waves by a strong wind blowing on the surface. The analogy is sufficient also as regards volume, for in times of plenty it expands whereas in lean times its volume is diminished and what is left has to be carefully husbanded at the expense of luxury.

In so far as the volume of industrial development can be controlled, therefore, the object must be regulation to a steady condition. Unsteadiness may be a symptom of inadequate control, or inability to cope with the more remote external influences. To take a modern industrial parallel, control is not complete without feed-back with which to sense change and to correct it when it begins and not after it has become disturbing.

The industrial pattern has always been one of swinging, with correction delayed until movement has become sufficient to produce marked effects which are difficult to get under control. So far the appreciation of feed-back—the beginnings of trends—has been lacking. The reason is possibly no more than that there are too many different effects involved for human capacity either to comprehend them or to deal with them in time. Nowadays, of course, the computor is available to make up for the latter deficiency, but the programme for it to work to has not yet been produced.

LOG SHEET

Fuel Saving

The report to the board of the National Fuel Efficiency Service by the chief executive, Dr. W. Angus Macfarlane, gives particulars of a number of instances where the service has been instrumental in effecting marked improvements in fuel utilization.

In May, 1957 a test was carried out on an oil-fired rotary fertilizer dryer at the plant of Robert Stephenson & Son Limited, Beverley. As a result the combustion chamber was re-designed and ducting was installed to re-circulate gases from the kiln exit fan to the inlet. Before these adjustments were made fuel oil consumption was 6·25 gallons per ton of product. This was reduced to 4·4 gallons. In December, 1957 a second survey was made which showed that, by insulating the ducts and using pre-heated air, consumption could be further reduced to 3·8 gallons per ton of product. An interesting feature is that Messrs. Robert Stephenson say the quality of the product has also improved so that an unexpected bonus has come from the improved fuel efficiency.

An expenditure of £4000 has made possible a weekly saving on fuel bills of about £150 at the paper mills of George Stark & Sons Limited of Glasgow. A heat and power survey was made in June, 1956 and the following recommendations subsequently carried out.

1. Steam engine scrapped and electric motors fitted.
2. Complete system of condensate return installed.
3. CO_2 recorder, steam meter, temperature recorder and draught indicator fitted.
4. Boiler plant insulated and steam piping improved.
5. Plant operated on one instead of two boilers.

Fuel consumption which was 60 tons a week, can now be stabilized at below 30 tons. The firm has made a regular service agreement with N.I.F.E.S. to ensure the continuance of a high standard of plant operation.

A heat and power survey carried out on a textile mill in Northern Ireland indicated that a saving of 9·6% of fuel (14% financial) could be made. In less than a year after the issue of the report the firm reported that annual fuel consumption had actually dropped by 16·8% even though all the recommendations had not yet been put into effect. The capital expenditure involved in effecting the saving amounted to less than half of the annual financial saving.

Rocket Base

The new British rocket base which is now under construction at Spadeadam Waste, near Gilsland in Cumberland, will provide facilities for the full-scale testing of rockets, components parts and ancillary equipment. Specialist apparatus will be installed for the construction, servicing and testing of missiles and there are a number of stands where static tests will be carried out.

British Oxygen Wimpey Limited is at present engaged in assisting the Ministry of Works in putting up the test stands, together with observation posts and other buildings which are needed for this major rocket project. The resources of British Oxygen are being used for the design and supply of some of the specialist plant, and the resources of George Wimpey Limited are being used to carry out the building work.

The Spadeadam Rocket Establishment is being erected on a site which comprises many square miles of moorland. Five miles of roads have been laid and others are in the course of construction. Many buildings have been completed and others are rapidly taking shape.

For the purpose of recording the performance of missiles under test, an intricate instrumentation system is necessary, involving long instrument ducts, recorders and control and recording rooms, etc.

Plant and transport shops where service vehicles and mechanical equipment used for excavation can be repaired and maintained have been built. A permanent electricity sub-station with a new grid line is being constructed and until this is completed, temporary supplies are being fed from Gilsland.

Two 400 ft bore holes have been sunk and three water towers have been constructed so that water can be distributed throughout the site. Floodlights have been set up on the hillside so that work can go ahead at night. To accommodate men who were recruited from outside the area to work on the site, a big labour camp has been set up. About 200 men are now living in modern buildings which include a recreation hall, chapel and a canteen.

There is also a reception centre and sick bay, and the site has its own fire station. The isolation of the site means that there should be little disturbance to local residents.

Hydromechanics Research

The British Hydromechanics Research Association has now been in existence for ten years since its legal formation. Its early years were precarious and it did not get a laboratory until 1951. It has prospered however, and this last year has probably been the most active since its formation.

The tenth annual report shows that research during the year included a number of interesting and useful projects. Progress has been made towards a better understanding of two chief causes of loss in centrifugal pumps—skin friction and casing geometry. The former is important in high head pumps and arises chiefly from surface roughness. The latter concerns loss on the side walls opposite the impeller shrouds and a tight volute design is indicated as a cure.

The measurement of hydraulic friction on rough surfaces, the hydraulic transport of solid material in pipes, the design of suction intakes, the dispersion of water from nuclear power stations, the flow in rainwater gutters, low loss flow meters, diffusers, seals and glands, control systems, the oscillation of hydraulic valves, and hydraulic transmissions—these are some of the subjects under investigation.

The association is also experimenting with four models of parts of the Ffestiniog pumped storage project. These are a 1:30 scale vortex model of the Stwlan Reservoir and the two intakes, and a 1:240 scale model of the same, also used to study vortex phenomena. Flow conditions and head losses are being studied on air models, to a scale of 1:14·5, of an intake and upper and lower bends and a bifurcation.

Power at Brussels

Power and lighting for the British Industries Pavilion and the British Government Pavilion at the Brussels Exhibition are controlled by two sub-stations. No. 1 sub-station at the north end of the Pavilion is virtually a glass showcase containing an English Electric sub-station in the dual role of controller of electrical supplies and a working exhibit of the latest type of electrical equipment. Among the exhibits provided by The English Electric Company and three of its associated companies are a giant rotor disc for a 200,000 kW steam turbine and a replica, 20 ft high, of a runner for a 125,000 hp water turbine.

Apart from the stand of the English Electric—Babcock & Wilcox—Taylor Woodrow Atomic Power Group at the Exhibition, the nuclear power interests of the Group are also represented on the United Kingdom Atomic Energy Authority stands and the British Electrical and Allied Industries Section stand. On the first of these stands is a model of the Hinkley Point power station, the first 500 megawatt atomic power station in the world. On the second stand there is a painting showing the reactor building at Hinkley Point Station.

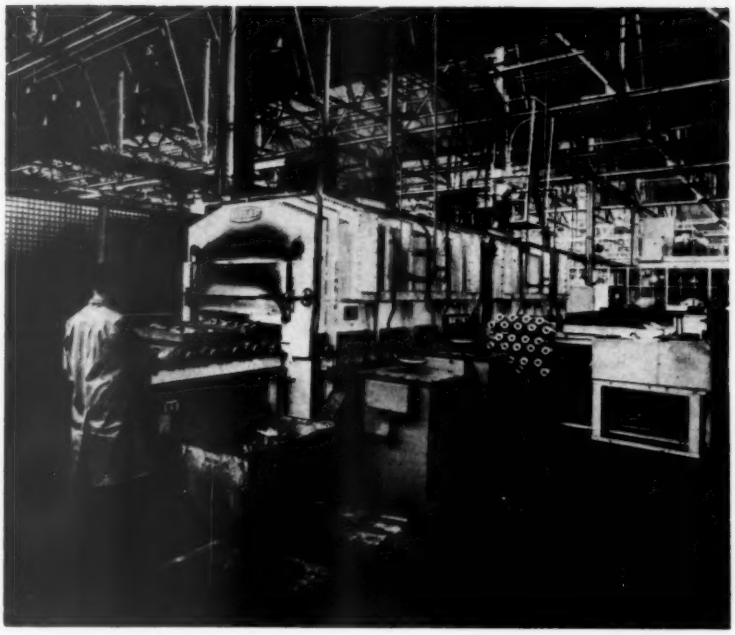
Talking on the Job

In collieries where winding engines for coal haulage are housed in towers high above ground level, changing the steel winding ropes when they become worn always presents a problem. At Rothes Colliery, Fifeshire, this difficulty has been eased by the installation of a new sound supervisory system developed by Communication Systems Limited. The system consists of a number of plug-in points placed at intervals between ground level and the top of the tower. Portable microphone-loudspeaker units can be inserted in any of these positions and messages, or instructions, passed throughout the system.

The portable units are fitted with "call" and "speak" push buttons. Operators can move from point to point as the winding rope is hauled up and receive verbal instructions continuously. A message passed from any point is heard in every part of the network, thus enabling all employed in the operation to know exactly what is happening immediately. An operator wishing to make an announcement presses the red "call" button, which produces a warning note in all the loudspeakers. He then presses the green "speak" button, and holds it depressed while broadcasting.

During transmission of a message, the local loudspeaker is muted, or partially attenuated, to avoid feedback. At the main control office, a fixed bulkhead microphone unit can be used instead of portable sets. A central amplifier of suitable power output is also housed here.

A system using a number of fixed type bulkhead units is also being employed at the Rothes to help speed the flow of coal from the pit, through the preparation plant, and to the awaiting railway wagons. This plant, which employs the latest grading and washing equipment, is designed to handle 250 tons of coal an hour, and it is absolutely essential that bottle-necks should not occur in any section. Efficient control has been ensured by installing twelve bulkhead units at key points. These make it possible for a stoppage anywhere to be made known immediately to those controlling or supervising mechanical operations, and for the manager to pass instructions which can be heard throughout the plant.



HEAT TREATMENT PLANT.—The electric furnace at Jaguar Cars Limited is used for normalizing welded components and stress-relieving partly machined crankshafts and gear blanks. The work is carried continuously through the furnace on driven rollers. First there is a short loading section, then a high temperature (950°C) furnace followed by forced draught cooling over 2 ft 6 in. then a 10 ft low temperature furnace and finally a cooling chamber. For long term annealing both chambers are kept at the low temperature, and for short term the work is put in a side door between the sections. Temperature control is by four Foster indicating controllers

Tanking Operation

A new building is being erected in Southwark, London, at a point where the water level is only four feet below ground level, and since the basement is an essential feature it is being made as an asphalt-lined tank. The first stage in the construction of the walls was to sink a coffer dam of interlocking sheet piles through the water-carrying earth and into the clay subsoil. These were then faced with an 18-in. concrete skin wall on which was laid a waterproof skin comprising three coats of asphalt, leaving 'weep spaces' every few feet which were made good immediately prior to the building of the reinforced concrete wall.

The basement floor is a concrete raft supported on bored piles. On this was laid 1⅛ in. asphalt, which was immediately covered with a protective coat of concrete 1½ in. thick. On this was superimposed a leading coat of concrete and the final floor screed.

The architects are Messrs. Ellis, Clarke and Gallannaugh, and the contractors Messrs. Trollope & Colls Limited and The Limmer & Trinidad Lake Asphalt Company Limited.

Changes at N.P.L.

Reorganization at the National Physical Laboratory has involved the former Divisions of Electricity, Metrology and Physics and the Test House becoming three new Divisions called Standards, Applied Physics and Basic Physics.

The Standards Division is responsible for all fundamental work on standards of length, mass and time; of electrical and magnetic quantities and also of temperature. Basically it consists of the old Metrology Division, expanded to include certain work on standards which was done in the Electricity and Physics Division. The Applied Physics Division is responsible in general for work in the field of classical physics of fairly immediate value to industry (but excluding optics, all of which continues to be done in the Light Division). The principal areas covered are electrotechnics, acoustics, heat and radiology. Test House, which formerly came under Administration, has become an integral part of this Division. The Basic Physics Division is responsible for pioneering developments in certain branches of non-nuclear physics which have potential industrial applications in the less immediate future.

Tea Blending Conveyors

The cleaning, blending and packing of tea usually requires extensive premises with a second, third or fourth floor, with the loose tea being gravity-fed to the various stages. At the new Bletchley premises of Joseph Tetley & Co. Limited, however, every operation, from the reception of the tea in bulk to the final packing is carried out on one single floor.

Initially, cases of tea straight from the docks are brought to the first stage-cleaning where vibrated screens sift the dust and any other foreign matter from the leaves. The cleaned tea is then moved through two separate totally-enclosed conveyor shafts, powered by low-power electric motors, into two reserve hoppers immediately above the large rotating tea-blending drums. Each elevator serves an individual hopper. When ready, the tea drops into the rotating drums which blend it to the requisite mixing.

The Redler 'en masse' system, specifically designed for the purpose, allows the blended tea to be drawn off from the drums in three ways. First, it can be channelled into chests for bulk despatch, and secondly into special canvas bags for short term factory storage. The third method is that it can be drawn from each of the two blending drums into individual twin elevators—each drum feeding a separate twin-elevator system, so that when one drum is stationary, the other continues to keep the tea moving.

These twin-elevator shafts feed a further conveyor system carrying the blended tea into various hoppers located above the individual packet-filling machines, which provide the final link in the chain of operations. The conveyors can be used to make the tea flow in either direction in order to suit the requirements of the filling machines.

The consulting engineers were Henry Pooley Limited and the conveyors were made by Redler Conveyors Limited, of Stroud—who worked in close collaboration with the tea company engineers.

Elliptical Gears

What is described as one of the most difficult production problems ever attempted by David Brown Industries Limited, Huddersfield in their hundred years' experience of gear manufacture concerns a pair of small gears, each just under 2½ in. dia. Elliptical in shape and with a difference between the major and minor axes of 0·14 in. the gears are a vital part of the flying controls of

A special machine tool had to be evolved by the David Brown Automobile Gear Division, Huddersfield in order to cut these elliptical gears, eight pairs of which are used in the flying control mechanism of each Bristol Britannia air liner. The inner serrations serve to match the eccentric centres.

the Bristol Britannia air liner. Each half-inch outer face has 71 teeth of 30 diametral pitch. The inner serrations seen the illustration serve to match the centres which are themselves eccentric in that they are bored ½ in. off centre.

Several manufacturers were invited to solve this intricate gear cutting problem but only the Huddersfield company accepted the challenge. The solution was found by the company's Automobile Gear Division, who evolved a special machine tool for the purpose. Eight sets of the gears are used in each aircraft and hundreds have been made since the Britannia went into production. Enquiries for further quantities have been received from aircraft constructors in Northern Ireland, and Canada where civil and military versions of the Brittania are being built.

Tornado Fans at Brussels

Three standard fans represent the Tornado range of Keith Blackman Limited at the Brussels Exhibition, on the stand of the Birmingham Engineering Centre.

The first is the No. 12 centrifugal, multivane type for general ventilation and air conditioning applications, mechanical draught, cooling and drying in connexion with various manufacturing processes. Second is one of the Type APA propeller type fans for use where large volumes of air have to be moved efficiently and quietly under free air or slight resistance conditions, for example for foul air extraction from, or fresh air supply to, public buildings and industrial plants. APA fans are, also, eminently suitable for steam removal, drying work and air circulation in connexion with refrigeration. The third exhibit is the very well tried and proved Bifuricated type fan which, since its introduction into the U.K. some seven years ago and due to its unusual but practical design, has been made in very large numbers for handling actively corrosive fumes, for moving hot air and other gases created in industrial processes and for mechanical draught.

Protecting Hydraulic Rams

After lengthy exposure to a highly corrosive, salt-laden atmosphere the Fescolised rams used in special hydraulically-operated gangways at Southampton Docks have been inspected and found to be in almost perfect condition. The covered, telescopic gangways, which are used to embark and disembark passengers on the *Queen Elizabeth* and *Queen Mary* lead into turrets mounted on rails so that they can be moved along the dockside and aligned in the correct position. The length of the gangway can be varied by telescoping one section into the other.

Each of the six gangways is fitted with two luffing and two slewing cylinders of the double-ended type, with piston rings fitted to the ram head. After the gangways were installed in 1949, it was found that the exposed surfaces of the steel rams were becoming heavily pitted by the corrosive action of sea spray, and the British Transport Commission specified that they should be sent to Fescol Limited (North Road, London N7) to be built-up by nickel deposition and given a surface finish of chromium.

To prevent all the gangways being taken out of service at one time the 26 rams, which included two spares, were treated in batches over the period 1953–1956. The Fescolised rams were returned direct to T. H. & J. Daniels Limited (Stroud, Glos.)—suppliers of the original hydraulic equipment—who then rebuilt the relevant cylinders and honed the bores. The work was carried out under the supervision of Mr. J. H. Jellett, O.B.E., M.I.C.E., Docks Engineer, British Transport Commission. Since being reinstalled the rams have shown no trace of wear or corrosion, although some of them have been in use for nearly five years.

This treatment has since become almost standard practice with rams in docks and shipbuilding yards, where hydraulic presses are generally water-operated and are invariably exposed to salt atmosphere.

Saunders and Safran at Brussels

A vertical, "Christmas tree" arrangement has been adopted by Saunders Valve Company Limited for their display in the British Industries Pavilion at the Brussels Exhibition, and by this means they are able to show seven types of valve and an example from the Safran pump range. The pump forms the basis of the display and on it is mounted the new KB straight through valve. In addition to the basic handwheel-operated valve there are a lever-operated, quick-acting type and two pressure-operated types, both diaphragm-operated, one for pressure opening and one for pressure closing, the former having a spring to close in the event of a cut in pressure and the latter being arranged to take an auxiliary handwheel where this is required. A hard rubber lined valve body is used to indicate the range of rubber, glass and lead-lined valves.

Outsize Autoclave

The manufacture of new building materials by modern methods calls for equipment and plant which although simple to operate is never the less of highly specialized design. For many years Rye-Arc Limited of London have been supplying special purpose plant and at present they are making six giant autoclaves for the Thermolite factory at Birmingham. Each of these autoclaves is 105 ft long and 7 ft 2 in. inside diameter, and weighs over 45

45-ton autoclave mounted on special bogies for transporting by road

tons. Of all-welded construction they are fabricated from $\frac{3}{4}$ in. plate for the outer shell and from $\frac{13}{16}$ in. plate for the dished and flanged end, the other end being fitted with a patent boltless quick action door. Each autoclave will be made in two sections with a bolted flanged joint to provide means of extending at a later date.

When installed and in use the autoclaves will be steam heated. Inside, running their full length is fitted a section of track to facilitate the easy entry of loaded wagons.

The transportation of the first one presented many problems and the haulage contractors—Messrs. Annis Transport—eventually decided to use one towing unit and two specially designed bogies.

Whilst these vessels represent some of the largest ever produced by Rye-Arc Limited, their Silvertown Works are equipped to undertake larger and heavier fabrications with rolling capacity up to 2 in. plate, and the majority of work undertaken today conforms either to Lloyds classification A.P.I., A.S.M.E. codes or A.O.T.C.

Ship Propulsion Trends

The new 45,000-ton turbo-electric passenger liner, No. 1621 being built by Harland & Wolff Limited at Belfast, the *Canberra*, will have British Thomson-Houston propelling machinery with features which give an indication of future trends.

Two 32,200-kVA single-cylinder propulsion turbo-alternators will normally supply independently two double-unit 42,500 shp propeller motors each driving one of the two screws. Developed from land machines, a number of which have been, and are being, built for power station purposes, the turbines are designed for inlet steam conditions of 700 psig, 950° F. As propeller reversals will be obtained electrically, the turbines are uni-directional and, consequently, no limitation of steam conditions is necessary during manoeuvring; nor is there any limitation to the astern power available. Full power astern may be a feature of particular importance in future ships using turbo-electric drive for nuclear propulsion, where safety may demand rapid manoeuvring in an emergency.

In the *Canberra* advantage has been taken of the flexibility offered by the electric drive in the arrangement of the propelling machinery, by placing the engines well aft to leave the amidships clear for passenger accommodation. This flexibility, due to there being no mechanical connexion between the prime movers and the propeller shafting, may be expected to show to advantage in the nuclear-powered ship where the positioning of the atomic reactor will certainly be determined more by safety and weight conditions than by optimum engine room layout.

A further feature of the new liner, which may point to a future trend, is the improved consumption permitted by the powering of both propellers from one turbo-alternator at reduced speeds. With the tendency towards larger tankers and twin-screw propulsion, interest is being shown in the proposal that the two screws should be powered by a single prime mover with benefits both in capital cost and in fuel economy.

Titanium Offer

William Jessop & Sons Limited of Sheffield, whose new vacuum melting plant was described in our March issue, are making an offer to industry of supplies of their Hylite titanium on attractive terms for development projects. Pure titanium has only 60% the weight of an equal volume of steel and the Jessop Hylite range of titanium alloys possesses the mechanical properties of high grade steel.

Diecast Screw Threads

The utility of diecastings can sometimes be much increased by the incorporation of screw-threaded features. For maximum economy, screw-threads should be formed in the plane of the die-parting and the pitch should be as coarse as possible so that any dimensional errors that occur are small in relation to the thread form dimensions. The effect on thread functions of die displacements is discussed and a means of overcoming them described

By HIRAM K. BARTON

THE dimensional precision with which diecastings can be produced frequently renders it unnecessary to carry out machining operations since surface features can be formed in the die to a sufficiently accurate standard of planarity, circularity, alignment and combinations of these. Among the features normally produced by machining that can be incorporated in diecast components, screw-threads are notable for the very considerable economies that are often achieved. There are, nevertheless, some very rigid design restrictions and certain limitations of size and accuracy that must be understood and accepted if diecast threads are to be used with complete satisfaction.

In large measure these restrictions are identical with those that are encountered in every aspect of die design, for they stem from the basic fact that diecastings have to be removed without distortion from a rigid mould. It is the small size of the surface features involved, and the fact that they usually impose some specific axis of stripping and ejection that render the design of screw-threaded diecastings particularly critical.

It is unusual, though not unknown, for two threaded diecastings to be assembled together. More commonly, a diecast thread must assemble with a machined one; the thread form and standard of accuracy of the former must accordingly conform to that of the cut thread within acceptable limits. Whereas the limits imposed on the machined thread, whether external or internal, are intended to allow for tool-wear, errors of setting and so on, the limits on the diecasting must provide for varying thermal effects upon the cavity dimensions, changes in physical abutment of the various die elements and differences in total contraction among the castings produced under slightly different operating conditions.

Where internal threads are to be diecast, it is of course necessary to use a threaded core that is unscrewed from the casting after solidification. External threads can be produced in the same way, the threads being cut in a rotatable bush. Owing to the very great slowing down of the casting cycle that these methods entail, they are economically impracticable in by far the majority of applications. It is almost always cheaper to machine a thread than to unscrew a rotatory die element from a cast thread. For most practical purposes, therefore, it is only necessary to consider in detail diecast threads that have their axes in the plane of the die parting and which in consequence can—if of appropriate form—be removed from the die by normal straight-thrust ejection.

Pitch of diecast threads

Because of contraction, the pitch of a diecast thread differs from that of the threaded cavity from which it is produced by roughly one-half of one percent; for a casting in zinc-base alloy having a nominal pitch of ten threads per inch the pitch of the cavity thread must be 0·1006 in. Under average casting conditions this results in a cast thread that, when the casting is cooled to room temperature, has shrunk to the correct pitch. The dimensional change is so small that when the length of engagement is less than half an inch or so it is often allowable to disregard it when sinking the cavity; the cutting of threaded cavities with 9·95 threads per inch —as required in the instance cited— is attended with considerable difficulty and should be avoided if the conditions of assembly allow.

In this context much naturally depends upon the fineness or coarseness of the thread, for thermal contraction and expansion affect the thread to the same extent whatever the pitch, while as a rule the coarser threads are more tolerant of dimensional error. It is necessary, however, to take into account the possibility of dimensional variation between one casting and another. Under extreme conditions the thermal variation may range from 0·002 in. above, to 0·002 in. below, the mean value of 0·006 in. per inch already noted. In practice a smaller range of variations is usually maintainable, and the standard linear tolerances recently adopted by British commercial diecasters can readily be held. These provide for a variation of plus or minus 0·002 in. on the first inch, plus or minus 0·003 in. on two inches, plus or minus 0·004 in. on a three inch length, and so on (all values are for zinc-base alloys).

These limits apply to dimensions taken along the thread axis, of which pitch is the most important. In respect of dimensions normal to the axis, the achievable accuracy is somewhat less since there is always a likelihood that the registration and abutment of the two die members will vary in the course of operation. The resultant displacements of the two halves of the diecast thread can simulate various sorts of dimensional error and distortion, even though each half considered by itself is accurate in form and size to a high degree.

The simplest displacement results from imperfect abutment, registration of the die members being unaffected. This increases the apparent diameter of the component, as measured along a line normal to the die parting, by an amount equal to the separation of the two blocks (Fig. 1). When gauged after

trimming, the component appears to be oval and a button die run down the cast thread removes a great part of the crests. Only near the parting line is the as-cast surface left untouched, apart from any scoring sustained during the trimming operation.

The two members may also become slightly out of register, with or without gaping at the parting-plane. The effect of imperfect registration is to make one die-block sag slightly in relation to the other, so that the effect upon the diecast thread is likely to vary according to the orientation of the thread axis with respect to a horizontal line drawn across the machine platen. If the axis of the thread is horizontal, the most probable displacement is a lateral one, the two halves of the thread being disposed as shown with much exaggeration in Fig. 2. The effect in the ring gauge is again one of ovality, but when the thread is run down with a die it can be seen that most metal will be removed from locations at the end of the major axis.

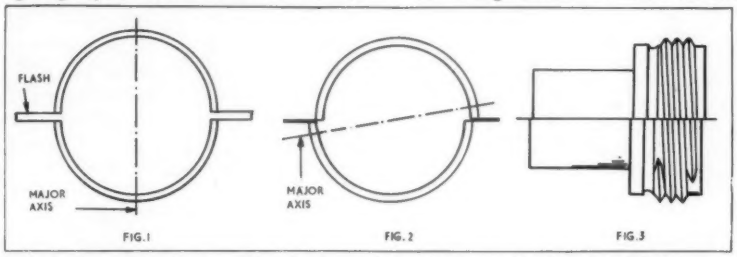


Fig. 1. Ovality resulting from incomplete die closure. Fig. 2. Ovality resulting from lateral displacement of die members. Fig. 3. Axial displacement of the two halves of the casting causes an apparent error of helix angle

These two effects are of course likely to occur simultaneously, the major axis of the "ovality" being shifted towards or away from the die parting according to which displacement is predominant. There are several ways in which the resultant dimensional errors can be countered or mitigated, the simplest being to cut the thread in the cavity a few thousandths of an inch undersize. Since some flash is almost inevitably formed at the die parting, the resultant castings are within limits across the parting and will be passed by a ring gauge. Although this may seem rather a crude procedure, it is in fact adequate in nine out of ten applications of diecast threads.

Actually, the more usual procedure is either to cut the thread with the two cavity members separated by shims, thus providing a gap similar to that which will obtain in service, or to cut the thread with the blocks clamped in close abutment and subsequently to grind 0·005 in. or so off the face of one of them. Whichever course is adopted, incomplete closure of the tool during operation—if not outside the forecast range—brings the castings to a full circular form. However, the undersize thread tolerates a small amount of lateral displacement also, whereas the full-size thread corrected for flash formation does not.

Axial displacement of the two die members results in imperfect coincidence of the thread form across the die parting (Fig. 3); this is immediately seen when the components are trimmed since the tool broaches the flanks of the threads. In a ring gauge, axial displacement prevents the component from entering more than one or two threads, since in effect it changes the helix angle. A die run down the thread cuts opposite flanks in the two halves of the casting. Axial displacement, taken alone, rarely exceeds the limits that will allow assembly of the mating nut, but it may, of course, occur simultaneously with some other type of displacement. The nearer the diametral measurements to the top limit, the less is the axial displacement that will yield an acceptable fit.

Although the foregoing comments refer specifically to cut threads, they apply equally to threaded cavities formed by hobbing. This process can be used to sink cavities of conventional form, but it is usually advantageous to modify the cavity form in some respects when hobbing is adopted. As is no doubt evident, even small displacements of the two halves of the thread result in unsightly scored or burnished flanks; metal is inevitably cut away from some part of the thread profile if there is the slightest degree of misalignment. However, even with perfect registration the trimming tool must be constructed with very great precision if it is to trim cleanly without either leaving a burr or cutting into the casting.

There is thus considerable advantage in designing threaded parts so that they do not call for a trimming die with accurate tooth forms, and this is made possible by adopting a form of thread like that illustrated in Fig. 4. In principle, this is similar to a normal machined thread which has parallel flats milled a little below the minor diameter. The diecast version incorporates a slight draft on the flats, and the ends of the arcs of full thread are rounded slightly to facilitate cavity sinking and assist engagement of the component and its mating part. The trimming tool for such a thread has two straight edges, and in practice it is not necessary to shear very closely since even if there is a burr of 0·006 in. or 0·008 in. left at the parting, this cannot wedge into the thread groove at assembly, as easily happens when a full circular thread is cast.

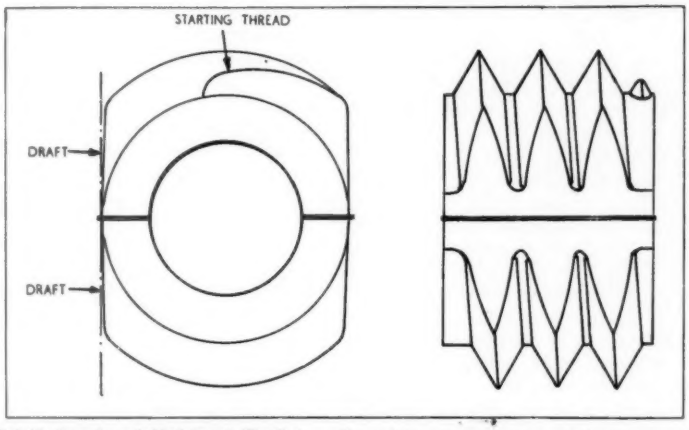


Fig. 4. Suitable form for a hobbed thread. The flats facilitate trimming and minimise the effects of small displacements of the die blocks

An interrupted screw thread of this type is readily reproduced with a pair of hobs, and the hobs themselves are appreciably easier to make than are similar tools with a full 180° thread, since in those the thread flutes must be carried up the sides of the hob. There are, however, other advantages too; the range of thread forms that can be produced is much greater than for full circular threads and multi-start threads can be produced without difficulty.

The limitations upon normal diecast thread forms are readily understood from an examination of Fig. 5. This represents in plan a semi-circular cavity with two sets of grooves. Those at A and B have zero helix angle, i.e., they lie in a plane perpendicular to the axis of the cavity, while those on the right are helical and lie on a screw surface having the same axis as the cavity. It will readily be seen that the semi-circular grooves can be of any form —so long as there are no re-entrant portions—without raising any difficulty at ejection. Where the groove has a lead angle as on the right, there are by contrast definite limitations upon the form since not all are freely ejectable.

The square groove C, for example, entirely precludes free ejection if there is the slightest lead, since this gives rise to undercuts at the ends of the threads as shown in the figure. A small departure from the square form, to the Acme form illustrated at D, permits a small helix angle to be adopted without undercuts being formed. With thread forms approximating a triangle (E) the possible helix angle is considerably greater. For a groove of *any* form, nevertheless—no matter how shallow—there is a limiting helix angle beyond which the component cannot be ejected without dragging.

Since multi-start threads have larger helix angles, the limiting form is shallower—that is, the included angle is greater—than for comparable single-start threads. Thus it is practicable to cast single-start threads of Whitworth, B.A., B.S.C., Unified or Metric form in a split-cavity die with the thread carried right to the parting-line, but multi-start threads of these or other forms, if to be complete over a full 360°, must be cast in an axially threaded cavity from which they are subsequently unscrewed.

It will be obvious from Fig. 5 that the undercutting effect is confined to the immediate vicinity of the die parting except in the case of an absolutely square thread. If, therefore, an interrupted thread like that of Fig. 4 is functionally acceptable, threads of virtually any form, whether single- or multi-start, can be satisfactorily diecast and ejected without drag or distortion. The strength of such a thread is little less than that of a full thread; in practice it is found that differences

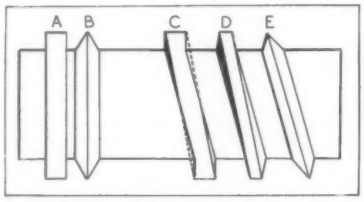


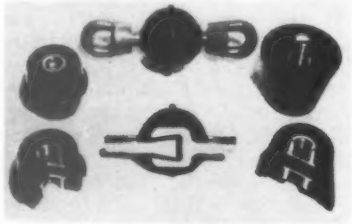
Fig. 5. The form of diecast threads is limited by the occurrence of undercuts near the parting line as the helix angle increases and the thread form approaches the square section of C

in depth of engagement, resulting from changes in flash thickness, have a much more direct influence upon the strength (resistance to stripping) of the assembly than has the continuity of the thread. It should be remembered, too, that as screw diameter increases and, presumably, the stresses likely to be encountered also increase, the angles subtended by the flats on each side decrease.

This should not be taken as implying that the method is less suitable for small-diameter diecast screw threads; although the reasons recommending its use are different, they are just as cogent. Small diameters and fine pitches are particularly difficult because they magnify the effect of small displacements of the two die members and are by no means easy to trim satisfactorily. Thus it may well happen that in a component having 32 threads per inch the axial displacement of the two cavity halves amounts to 0·004 in. or 0·005 in., or something like 15% of the pitch.

Such a thread is badly cut about by the trimming die, which shears a great part of the flank away adjacent to the parting. With an interrupted thread this damage does not occur, and in most applications the amount of axial distortion cited above does not in itself prevent the mating nut or collar from being run up the thread provided that the length of engagement is not too great. On all counts, accordingly, the interrupted thread is to be preferred to the complete one—which is far from complete after trimming if any displacement of the cavity members has occurred.

[1] *Engineering Standards for Pressure Die Castings.* Zinc Alloy Die Casters Association, 34 Berkeley Square, London, W.1.

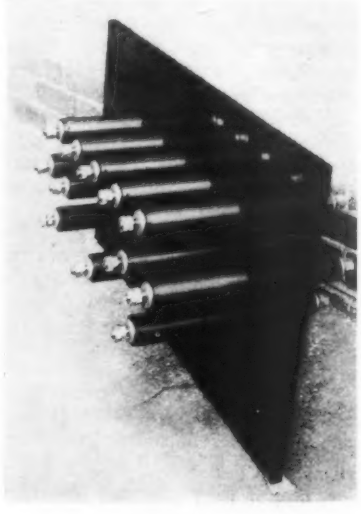


TUFNOL FOR INSULATION.—The high grade insulating properties of Tufnol offers considerable scope for electrical component manufacture. The 25 × 35 in. multi-way terminal board shown on the right is of Kite brand Tufnol sheet and tube; above a selection of bell, ball and barrel insulators, proof tested at 2 kV for 1 min, all produced by Tufnol Limited, Perry Barr, Birmingham 22B.

P.V.C. Ball Valves

Rigid P.V.C. ball valves which can be used with all types of inorganic acids have been developed by Rediweld Limited, 17–27 Kelvin Way, Crawley, Sussex. The Rediweld Double-Seal ball valve is fitted with a precision ball section which permits full opening of the valve with a 90° turn of the handle. Fluon gaskets provide the liquid-tight fit between ball and body of the valve and Fluon seals prevent leakage in the stuffing box.

The valve seats and gaskets are replaceable but will stand up to long periods of use without wear and the the valves are self-compensating for temperature and pressure changes. They are available in sizes from ½ to 2 in. B.S.P. with screwed ends, flanged ends or ends for welding.



Carburizing of Steel: Methods, Properties and Applications

Carburizing processes for steel are described and their relative applications and advantages discussed in the light of improvements which have taken place in recent years

By A. G. GARDNER, A.I.M.

STEEL parts for certain engineering applications often have to be produced with a hard surface to resist wear and a core that is relatively ductile. Depending largely upon the type of steel being used, and the final properties required in the processed parts, a choice has to be made concerning the best methods of producing the hardened case.

Carburizing is the most common method of producing a hard surface on steel. Although this technique has been employed for a considerable time, developments in recent years have improved the reliability of the process and have led to the increased use of the gas and liquid carburizing methods.

The oldest method is known as pack carburizing, which basically consists of heating the steel in contact with a carbonaceous material within boxes sealed to exclude air. The beginnings of this method are lost in antiquity, but it is still widely employed today.

In the latter part of the nineteenth century it was found that steels could be carburized by exposure to a relatively unstable carbon-bearing gas, but for many years the process suffered from poor furnace design and construction and insufficient knowledge of the carburizing reactions. Such conditions have now been overcome and the improved methods of control have resulted in a process which yields good results provided proper precautions are taken.

Liquid carburizing, the most recent method, is a development of the cyaniding process, which consists of heating the steel in contact with a suitable sodium cyanide bath. The case formed contains both carbon and nitrogen and is normally rather shallow and harder than the usual carbon case. The discovery of the possibility of adding compounds to increase the activity of the bath led to the production of deeper cases which more closely resembled those obtained in pack and gas carburizing than those produced in the cyanide bath. The process thus became known as liquid carburizing.

This article describes the various methods of producing a carburized case and reviews the properties and applications of such cases.

Pack carburizing

This process normally consists of packing the components in a carbonaceous material within boxes, which are then sealed to exclude air. The boxes are heated for several hours according to the depth of case required at approximately 900°C. The actual temperature is of great importance and depends upon the type of steel being treated. Portions of the components which are not to be hardened are protected by the application of a substance which does not absorb carbon and is usually referred to as a "stopping off" compound.

Carburizing compounds are usually based on hard wood charcoal and contain carbonates as energizers or catalysts to promote more rapid reaction with the steel. Although there are numerous proprietary compounds on the market, they are all essentially similar and there is little difference in their effects. The usual compound contains from 70 to 90% charcoal, from 5 to 20% energizer in the form of barium carbonate, and from 4 to 6% binder, which may be water, oil, molasses or tar.

Case depth depends on carbon potential, time and temperature. Although certain elements, if present in sufficient quantity, affect the rate of diffusion of carbon into the steel, this rate appears to be independent of composition for the carbon and low alloy steels usually employed for carburizing. The carbon potential is the difference between the quantity of carbon which is soluble in the steel at the carburizing temperature and the original carbon content of the steel. The carburizing temperature is the most important variable in the process and the influence of both temperature and time on case depth is set out in Table I. This table applies to the low carbon, low alloy steels normally employed for carburizing, such as En 32, En 33 and En 34. The latter two types do contain 2–3% of nickel but this does not appreciably affect carburization.

Table II shows the influence of time (in hours) and temperature on the case depth of alloyed carburizing steels.

Table I.—LOW CARBON AND LOW ALLOY CARBURIZING STEELS : INFLUENCE OF TIME AND TEMPERATURE ON CASE DEPTH

(Values of case depth in inches)

Time at Temperature	TEMPERATURE °C				
	850	875	900	925	950
hr.	in.	in.	in.	in.	in.
1	0·016	0·019	0·021	0·024	0·028
2	0·022	0·026	0·030	0·034	0·040
3	0·027	0·032	0·036	0·042	0·048
4	0·031	0·037	0·042	0·048	0·056
5	0·035	0·041	0·047	0·054	0·063
6	0·039	0·045	0·051	0·059	0·069
7	0·042	0·049	0·056	0·064	0·075
8	0·044	0·052	0·059	0·068	0·080
9	0·047	0·055	0·063	0·073	0·085
10	0·049	0·058	0·066	0·076	0·089

Table II.—ALLOYED CARBURIZING STEELS : TIMES AND TEMPERATURES TO PRODUCE CERTAIN CASE DEPTHS

(Times are in hours)

Steel	Temperature	0·010 in.	0·020 in.	0·030 in.	0·040 in.
	°C	hr.	hr.	hr.	hr.
En. 35 & 36	900	1·0	1·9	4·2	7·5
En. 35 & 36	925	0·7	1·4	2·8	5·0
En. 35 & 36	950	0·4	0·9	1·9	3·4
En. 37	880	1·5	2·4	6·0	10·7
En. 38	900	1·2	2·1	4·4	7·8
En. 39	925	0·8	1·7	2·7	4·8

A variety of mechanical properties can be produced by pack carburizing at different temperatures, quenching then reheating to about 800°C followed by another quench. Although this treatment results in the best core and case properties, it is not used to the extent it was due to the number of operations and the amount of handling. The normal procedure nowadays is to quench direct from the box on extraction from the furnace, thus avoiding reheating. Alternatively, depending upon the composition of the steel, components are allowed to cool within the carburizing boxes and then reheated and quenched. After the double heat treatment it is best to temper the components at a temperature between 150°C and 180°C. This can be carried out in a forced air circulation furnace or a suitable salt bath.

Selecting steels for carburizing

A number of factors influence the selection of steels for carburizing. Basically, such steels must have the proper characteristics to allow them to absorb carbon at a reasonable temperature and rate, be hardenable without excessive distortion, and be heat treatable to obtain the desired core properties.

Steels for casehardening do not normally contain more than about 0·2% carbon since low carbon steels absorb carbon more readily than those of high carbon content. Higher carbon steels are sometimes carburized, usually with rather light cases for special applications.

For mass produced parts a simple alloy or non-alloyed steel can generally be used most effectively and economically. Most parts are casehardened chiefly to resist wear by friction and pressure. They may be regarded as made of a composite steel having a hard outer skin and a soft core.

Treating first with plain carbon steels, these may be divided into the following three types:—

(a) When components are to be water quenched for maximum case hardness and high ductility is required in the core, a steel containing between 0·08 and 0·15% carbon should be used.

(b) The most common carburizing steel which meets most engineering requirements has a carbon content which is in the range 0·15–0·20%.

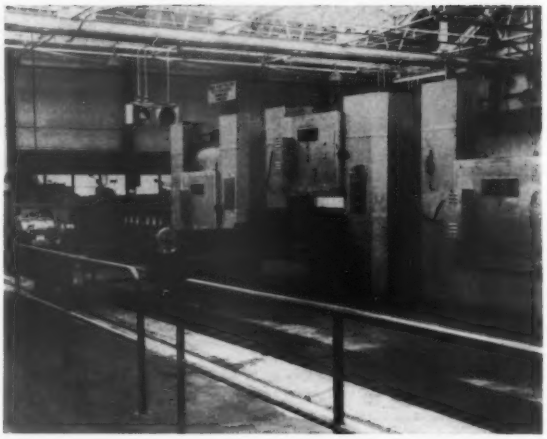
(c) Where parts are not subject to shock, a steel with a carbon content of between 0·20 and 0·30% can be employed.

For the majority of applications a case of about 0·015 in. is adequate.

The strength and toughness of the core may be increased by using a nickel alloy such as En 33, 34 and 35. Chromium, which is present in En 36 and En 39, is a carbide former, and increases the hardness and wear resistance of the case and also strengthens the core. Molybdenum, also a carbide former, increases the hardness of the case but is chiefly of value because it assists in retaining hardness to higher temperatures than occurs in steels not containing this element. It is present in En steels 34, 35, 38 and 39. In general the alloy steels give a much better combination of core properties after heat treatment than is obtainable with plain carbon steels. For mass produced parts, however, highly alloyed steel is a needless extravagance.

Carburizing boxes

Since carburizing boxes and their contents have to be heated from room temperature to the carburizing temperature, it is advantageous to use the smallest and thinnest container possible. Cast boxes were used extensively in the past, but in recent years relatively thin



Battery of multipurpose electrically-heated box furnaces, used for pack carburizing; boxes being charged by electrically-traversing charging machine

metal sheet welded to the shape of the box have come into increasing use. These boxes may have ribs for stiffening since they must have sufficient strength for handling at the carburizing temperature.

In order to minimize carburization of the container and thus prolong the life of the box, the modern practice is to use high nickel steels or nickel chromium alloys for the boxes. These materials suffer less attack from the carburizing gases than the lower alloy steels or cast irons used previously.

The lids of the boxes must fit fairly tightly in order to prevent excessive entry of air and consequent rapid destruction of the carburizing compound. However, escape of spent gas from the containers is advantageous in order to maintain a circulation of active gas around the work and the practice of sealing the boxes with clay is not now so widespread.

Packing the boxes should be carried out with considerable care in order to ensure contact between each piece of steel and the carburizing compound. Although such contact is not absolutely essential, there is a risk of non-uniform cases if such a procedure is not carried out. The mesh size of the compound should be fine enough to reach into holes and between gear teeth, but not so fine that it interferes with free circulation of gas; 3 to 6 mesh is a normal size. The work must remain completely covered with carburizing compound throughout the treatment and sufficient excess compound should be included to allow for settling during the carburizing cycle.

Where portions of components are not to be carburized, some means must be adopted to prevent contact of that area with the carburizing compound. This can be accomplished in one of two ways—firstly by plating a layer of copper on the part either selectively by masking, or completely covering the surface and then subsequently removing copper from surfaces to be carburized. Secondly, by using one of the various proprietary stopping off compounds which have been developed to prevent carburization of portions of the surface.

Furnaces

The main requirement of a furnace for pack carburizing is the ability to maintain a uniform temperature for the length of the carburizing cycle. Batch or continuous furnaces of various types are used, although these

need not be specially designed for pack carburizing and, in fact, they are frequently used for other heat treatment purposes. Fig. 1 shows a battery of multi-purpose, electrically-heated box furnaces used for pack carburizing.

After carburizing, the parts can be cooled in the box or removed from the compound and quenched. The latter operation can be accomplished by handling each individual piece or by dumping the contents of the box on an inclined screen with a mesh size selected to pass the compound but retain the work, which can slide directly into the quench tank.

Carburizing compound treatment

After use, the compound is mixed with new material to replace losses. The old carburizing compound must be regenerated between runs by allowing it to stand several hours in air. After use the compound should be screened to remove the extreme fines and to obtain a material sufficiently coarse to permit free circulation of the carburizing gas around the work.

Application of pack carburizing

Although pack carburizing lends itself to almost any design, it is essentially suitable for components which have considerable variations in section thickness. It is a method for which unskilled labour may be employed. Provided that the simple rules are followed and a reliable furnace used, there is little difficulty in producing uniform results.

Pack carburizing is particularly useful when certain parts of components have to be "stopped off". Many "stopping off" materials are only satisfactory when the parts to be treated are pack carburized.

Gas carburizing

During the past 10 to 15 years, improvements in design of furnaces and control of gaseous atmospheres have led to an expanded use of gas carburizing. This process is now replacing pack carburizing in an increasing number of applications.

The mechanism of gas carburizing is essentially the same as in all carburizing processes, that is, active carbon dissolves in the surface layer of the steel and diffuses inwards to form the hard case. In gas carburizing the active carbon is produced as a result of an interaction of the steel with carbon monoxide and/or a hydrocarbon which is readily decomposed at the carburizing temperature. This latter hydrocarbon can be methane, propane, natural gas, vaporised fluid hydrocarbon, or a similar material. The usual gas atmosphere consists of methane, carbon monoxide, hydrogen and nitrogen; the latter two gases are practically inert and play no appreciable part in the actual carburization reaction. In addition to the gases mentioned, very small amounts of oxygen, carbon dioxide and water vapour are often present. These last three gases have a decarburizing effect and are therefore, kept to the absolute minimum.

In the early days of gas carburizing, natural gas, manufactured gas or the like was passed directly into the furnace and allowed to react with the steel at a suitable temperature for a period of time which was determined by experience to give the depth of case desired. Forced circulation was not used, sooting was a major problem, and results were frequently very erratic.

In modern practice, the dependability has been improved by adequate sealing of the furnaces to prevent access of air and by forced circulation of the gas. It has been found that uniform cases over the entire charge can be obtained only if leakage of air into the furnace is prevented. Thus, furnaces are operated under a positive gas pressure and checks are made to detect leaks.

Methods of obtaining the gaseous carburizing atmosphere

As previously mentioned, the reaction mixture contains carbon monoxide, methane and hydrogen in suitable proportions and this must be produced in such a way that deleterious constituents such as carbon dioxide, oxygen and water vapour, are all removed or reduced to a minimum.

Several methods of atmosphere generation have been devised, but these may be divided into two main categories:—

(1) Those in which town's gas or piped methane are treated in a separate gas plant or generator, and in which, in most cases, enrichment of the gas by adding a hydrocarbon gas is employed.

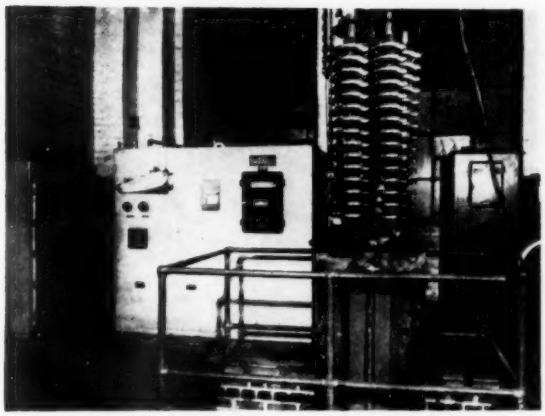


Fig. 2. Loading a retort with crown wheels. The gas preparation plant for the town's gas is shown in the left background

(2) Those in which a suitable liquid mixture is dripped directly into the carburizing furnace chamber with the intention of producing the reaction gas directly.

These two types of atmosphere generation will next be treated in a little more detail.

Atmospheres derived from gas

In the United Kingdom the starting point in atmosphere generation is raw town's gas. This can be treated in a number of ways to achieve a composition satisfactory for carburization, and two of the principal methods are described below.

In the first of these methods, town's gas is mixed with a controlled proportion of air, passed over a heated catalyst and burned endothermically. This results in a neutral or mildly carburizing gas whose composition can be controlled within the required limits by adjustment of the gas/air ratio. To give this carrier gas the desired carburizing properties, an accurately regulated flow of hydrocarbon gas is added. Propane or butane are the usual sources and an addition of 2–5% is generally found to be satisfactory.

The second method does not burn the gas during preparation for carburizing and air is therefore not added. The underlying principle of the process is the use of the carburizing agents naturally present in the gas so as to obviate the necessity of making a hydrocarbon

Fig. 3. Lowering a charge into a gas carburizing furnace the atmosphere in which is derived from a liquid

addition. This is achieved by passing the gas over a catalyst at elevated temperature. Decarburizing constituents—carbon dioxide, oxygen and water vapour—are largely removed, with the result that the carbon monoxide and methane contents are able to exert their full effect as carburizing agents.

The advantages claimed for this second method are that it is not necessary to achieve any balance of mixture to minimise sooting on the parts being treated, and a temperature can be employed which enables carburization to be carried out at the maximum theoretical rate.

Atmospheres derived from liquids

Atmospheres can be derived from suitable organic liquids, such as mixtures of alcohols and hydrocarbons, which are fed directly into the carburizing furnace at a strictly controlled rate, usually in a steady succession of drops. The liquid vaporizes and is circulated throughout the charge by means of a fan. The vapour decomposes and yields an atmosphere which has an effective carburizing potential of similar composition and results to those derived from town's gas.

Furnace design and operation

The furnace installation used for gas carburizing must necessarily incorporate the following basic features:

(1) A heated work chamber which is effectively gas tight when closed.

(2) Means to ensure uniform, free contact between the gaseous atmosphere and the charge.

(3) A heating system which can have no interaction with the furnace gases.

In addition, other features such as provision for quenching and cooling the charge under a protective atmosphere, may be required.

Gas carburizing furnaces generally employ one of the following three charge handling methods:

(1) Loading in fixtures or baskets by means of a hoist into a vertical pit type furnace.

(2) Loading in rectangular trays or baskets which are pushed on rails into a horizontal furnace.

(3) Bulk loading of loose parts into a rotating furnace retort which may be tipped for discharge.

When either of the first two methods is used, a fan is necessary to circulate the furnace atmosphere throughout the load to ensure uniform treatment. Rotary retort furnaces, however, rely on a gentle tumbling action of the work to expose the surfaces to the carburizing gases.

In order to prevent any interaction between heating elements or burners and the carburizing atmosphere, the work chamber should be sealed from the heating source. This is accomplished in one of two ways: a metal retort externally heated, or a direct loading furnace consisting of a gas tight outer casing with heating by enclosed electric elements or gas fired radiant tubes.

When an externally heated retort is used, the work to be carburized is loaded into a cold retort, which is then purged with the carburizing atmosphere and loaded into the hot furnace. At the completion of the carburizing period, the complete retort, with the charge in it still under a protective atmosphere, is removed and allowed to cool, thus ensuring complete freedom from scaling. This type of furnace is considerably more expensive in initial cost than the direct loading type and it may usually be considered preferably to accept the slight oxidation obtained when unloading the latter.

Generally speaking, similar furnaces are used for carburizing by town's gas or when the carburizing gas is derived from a liquid. The only difference is that in the latter case a modified door is fitted to allow the entry of the liquid into the furnace, whereas with town's gas, the carburizing atmosphere usually enters at the bottom of the furnace.

Fig. 2 shows a retort being loaded with crown wheels. The town's gas preparation plant is shown in the left background, whilst Fig. 3 shows a charge being lowered into a gas carburizing furnace whose atmosphere is derived from a liquid.

The total time at the carburizing temperature is divided into two parts, the "active" carburization period during which carbon is usually fed into the steel as fast as it can be absorbed, and a final "diffusion" period when the absorbed carbon is diffused into the steel according to the type of case required. During the diffusion period, the steel should be in a neutral atmosphere and the outlet valve is shut so that the atmosphere inside the furnace remains static. Alternatively, a neutral atmosphere can be passed into the furnace. The required ratio of "active" to "diffusion" times depends on the surface carbon required, the temperature and other factors, but is approximately two to one at the usual temperature of 925°C for a eutectoid surface on low alloy steels. For a given carburizing atmosphere usually of maximum carbon potential, depth of case formed is a function only of time and temperature. It will, therefore, be appreciated that the maintenance of a constant and even temperature throughout the furnace is an important point of design. Penetration times at 925°C for various case depths having a eutectoid surface are given in Table III and apply to all common carburizing steels.

The maximum carbon potential is normally employed for the carburizing atmosphere, and this must be carefully controlled. The usual methods of control consist of

carburizing a test piece with the work and examining it by various methods, analysing the gas at regular intervals, or determining the dew point of the gas. The dew point method is more sensitive than gas analysis and can detect changes in furnace conditions more rapidly. It is necessary, however, to prepare graphs relating the dew point to the carbon monoxide/carbon dioxide ratio for the atmosphere being used in the furnace; a recently developed instrument employs a steel wire which is carburized by the gas in the furnace and it is claimed that the exact control of the carburizing potential of the atmosphere is obtained. In an alternative arrangement a sample of gas is drawn continuously from the furnace and passed over a steel wire placed outside the furnace.

The basic advantages of the gaseous method lie in the ability to control more finely the case depth and carbon content, the shorter treatment time for a specific depth of case, and the smaller floor area required in relation to output obtained. It is, of course, generally cleaner and needs far less handling time.

Liquid carburizing

This method is tending to replace the pack method, particularly for specialized operations. In all industrially operated baths, the carburizing medium consists of cyanides. Originally, only sodium cyanide was employed and this bath is still used for producing light cases up to 0·010 in. deep when the process is known as cyaniding. These baths normally operate within the temperature range 730° to 885°C, and the cases consist of both carbides and nitrides. The latter predominate when the lower temperatures are used whilst at the higher end of the range carbides form the major portion of the case. A plain cyaniding bath should not, however, be confused with liquid carburizing bath.

True liquid carburizing baths are activated or catalysed. For cases of moderate depth up to about 0·040 in. they usually contain barium compounds, although when water soluble materials are required for ease of removal from the surface, acidic oxides, phosphates or fluorides can be used. Cases produced in activated baths contain a smaller proportion of nitrides than those produced in cyanide baths. The cases are also less brittle and more nearly resemble those obtained in pack and gas carburizing.

For heavy cases, all liquid baths contain barium catalysts. These baths have low cyanide contents averaging between 8 and 12% and operate in the higher end of the temperature range from 925° to 955°C, with a few installations operating at 980°C. The bath is always covered with powdered carbon or graphite to conserve heat and protect it from excessive contact with the air. This procedure is generally employed for cases between 0·030 and 0·100 in., although deeper cases can be produced. Although there is not complete agreement on the exact mechanism of carburization by a liquid bath, it does appear that active carbon is produced and this enters the steel without any sooting.

Table III.—PENETRATION TIMES FOR VARIOUS CASE DEPTHS WHEN GAS CARBURIZING AT 925°C

Case depth	Time
in.	hr.
0·010	1·00
0·020	2·00
0·030	3·25
0·040	5·00
0·050	7·00
0·060	9·25

As a result of the intimate contact between the liquid bath and the steel, the temperature of the latter is rapidly raised by conduction to the carburizing temperature. Since liquid carburizing baths also operate generally at higher temperatures than are used in gas carburizing, case formation and diffusion are more rapid.

The process allows of a fair degree of flexibility. Different depths of case can be obtained in the same bath by varying the carburizing cycle. Similarly, a component can be carburized selectively by immersing only the section to be case hardened and no stopping off is necessary. Parts carburized in liquid baths are free from scaling and decarburization, and there is no soot problem.

In order to present a balanced picture, it should be mentioned that liquid carburizing has certain disadvantages. As in the handling of all liquids maintained at high temperatures, care must be taken to prevent the entry of wet parts to the bath to prevent steam formation and "blow-out" of the liquid. Parts must be washed thoroughly after treatment to prevent rusting, regular adjustment of the bath composition is necessary to obtain uniform case depths, and some shapes cannot be handled because they would tend to float or cause excessive drag-out of the salt. The operator should wear safety goggles or a face mask at all times when working at these carburizing baths. Care must also be exercised in handling and storing the solid material. The salts must not be allowed to come in contact with acids otherwise hydrocyanic acid, a highly toxic gas, is produced. However, providing these points are recognised and suitable precautions are taken, satisfactory results can be obtained with the minimum of hazard, as can be demonstrated by the many cyanide salt baths in operation today.

The most popular method of heating the bath is by means of immersed electrodes. The heat is supplied by the resistance of the salt to the passage of an electric current. This method allows the greatest flexibility in design since the size and shape of bath can readily be varied without any reference to any external heating structure.

In conclusion, the author wishes to express his indebtedness to Wild-Barfield Electric Furnaces Limited, for supplying photographs and technical details of their carburizing equipment.

Rock Drill Rods with Stainless Steel Linings

Corrosion of the inner wall of drill rods, coupled with the increasing efficiency of rock drills has been for some time a substantial feature contributing to breakages in many types of rod. The Consolidated Pneumatic Tool Company, 232 Dawes Road, London SW6, have announced that they are now supplying C.P. Seco Steel with stainless steel linings to eliminate the incidence of failure due to this cause. Corrosion of the inner wall of untreated steel gives rise to points of weakness which are developed under stress until failure occurs. With the incorporation of a stainless steel lining into an already perfected tungsten carbide tipped drill rod, variations in the structure at heat treatment points have now been nullified and failure initiated by corrosion during rod life has been eliminated. Other advantages arising from the new lining are greater footage per rod resulting from higher fatigue strength, better flushing due to a correctly sized, smooth walled bore and greater economy in drilling.

Micro-recorded Data

A punched card system for extracting references directly from microfilm

A METHOD for making indexed information directly accessible and reproducible is being developed to increase the effectiveness of literature searching at the U.S. National Bureau of Standards. Proposed for use in the Bureau's instrumentation reference service, the "Microcite" feature, as it is called, consists of photographically storing greatly reduced copies of citations and abstracts (called micro-abstracts) so that they can be readily located and read. The technique was devised by J. Stern to improve searching with the "Peek-a-boo" filing and retrieval system used in the reference service. The "Peek-a-boo" information search system makes use of hand-manipulated punched-cards each of which represents an index term such as "electromagnetic", "detection", or "heat". The identity of documents to which the index term applies is noted by punching holes at appropriate locations on the card; the location of a hole is determined by the serial number assigned to the document.

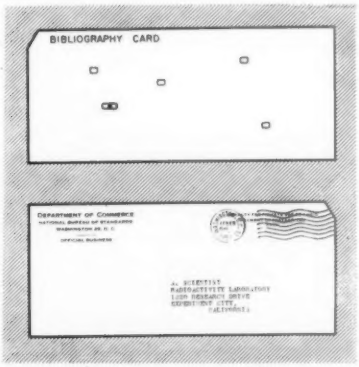
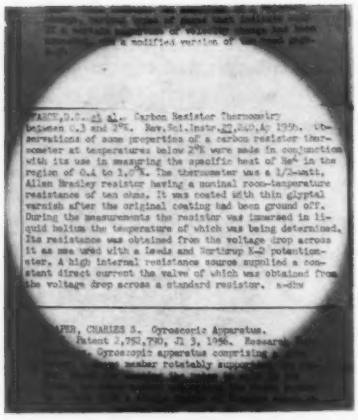


Diagram showing how Microcite could be used to print a bibliography on a post card. References are obtained directly by lining up a matrix film master card with punched cards describing the subject on which references have been requested. Light shining through coincident holes provides illumination for printing the proper references

To carry out a search, the investigator removes from the file a number of cards, each labelled with an index term associated with the type of references he is seeking. These cards are placed on a plastic reading illuminator which properly aligns them. Any holes common to all the cards will then be seen as small spots of light. In the basic Peek-a-book system the co-ordinates of these spots, determined with the aid of a numbered grid, identify the serial numbers of references common to all the selected cards; the serial numbers lead in turn to the actual references sought.

Viewing micro-abstracts through a microscope. When Peek-a-boo subject heading cards describing a particular instrument are stacked together in front of a light source, coincident holes are illuminated. A filmed matrix overlay with properly placed micro-abstracts would allow the references in question to be directly read through a microscope or by projection

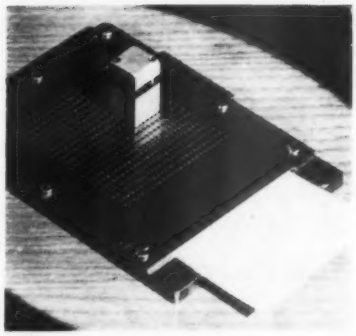
With the Microcite feature added to the Peek-a-boo system, information on the subject of interest appears as a direct result of superimposing the term cards, rather than requiring an intermediate serial number. In one version, the film containing the matrix of micro-abstracts can be placed over the stack of selected Peek-a-boo cards. The micro-abstract of each reference occupies just the position in its matrix that would otherwise represent its serial number. The micro-abstracts can be slightly larger than the serial number holes since no supporting area is needed between images as is required between perforations. A light diffuser between the search stack and the film matrix permits the small index holes to illuminate the larger areas of the micro-abstract matrix. The information sought can then be read by viewing the illuminated frames under a microscope. In the Bureau's experimental work on the Microcite feature, cards and matrix $3\frac{1}{4}$ by $7\frac{3}{8}$ in. are used with a capacity for 1000 micro-abstracts.



A filmed matrix of micro-abstracts can be constructed for use as an overlay in the Peek-a-boo system. Instead of yielding the serial numbers of desired references, this system will permit direct viewing of abstracts

With another Microcite technique under consideration, the Peek-a-boo holes would be used only to locate the abstract. Positioning a locating pointer of an automatic read-out device at a light spot on the card stack would cause the corresponding abstract to be illuminated and projected for reading. This arrangement would permit the indicating hole to be very much smaller than a micro-abstract, and would allow flexibility in distribution of the abstract positions.

For preparing bibliographies in answer to reference questions, the Microcite feature could also eliminate other time-consuming operations. If the film matrix (a negative in this case) were sandwiched between the search stack and a suitable photographic printing



Punching device for designating the serial numbers of references on subject heading cards

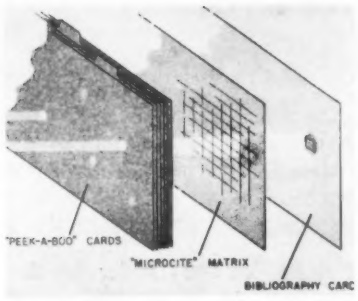


Diagram illustrating the Microcite system. Information is located by lining up index cards referring to different aspects of the subject of interest. Holes common to all the cards reveal information either directly through a microscope or for printing on sensitized paper

paper, light passing through the holes in the card stack would provide illumination for printing the selected references. The time and effort involved in duplicating the information for enclosure in a letter could therefore be avoided by printing directly on a sensitized postal card. In this way the reference information could be made ready for immediate mailing to the inquirer, who could read it on any of several commercially available micro-image projectors. Extensions of both the basic Peek-a-boo principle as well as the Microcite feature are being further investigated by Bureau scientists.

Improved equipment for punching and viewing the Peek-a-boo cards has been designed at the Bureau to provide a capacity of 18,000 document numbers with a card size of 5 by 8 in. Interest shown by several manufacturers indicates that equipment of this type may soon become commercially available. However, standard accounting machine cards and a hand punch are adequate for applying the Peek-a-boo principle to small collections.

References

"Instruments Reference Service," *NBS Tech. News Bull.* 39, 8 (August 1955).

"Basic Instrumentation at NBS," *NBS Tech. News Bull.* 37, 9 (September 1955).

"Punched Cards," edited by Casey, Berry, Kent and Perry. Revised edition to be published later.

Fault Location by Stethoscope

Audible sounds of mechanical distress in machinery often only occur when the damage to revolving shafts or bearings is past repair. With the Minear industrial stethoscope checks for faulty running can be made before serious trouble arises. By virtue of its high amplification and the external acoustic insulation of the binaural head-set, 'wanted' noises can be located and amplified to the exclusion of extraneous, unwanted noises. The stethoscope will detect aural defect symptoms such as the sound of dry or cracked bearings, metal under stress; fluids or gases flowing in pipes or leaking under pressure, and most symptoms of mechanical defect.

Listening to a lathe headstock bearing under running conditions with the Minear stethoscope

The instrument is battery operated and (apart from the detachable head-set) is entirely self-contained in a 10 oz chromium-plated case 8 in. long. Using transistors for economy of space and operation, the instrument has a chromium-plated probe, which is designed for easy handling and insulated to withstand high voltages. An on/off switch and thumb-operated volume control are incorporated, and the head-set sockets are situated at right angles to the body of the instrument, to prevent the cable becoming entangled with the apparatus under test. Power is supplied by a standard Mallory battery with a life of 2000 hr. The makers of the Minear are Airsonic Limited, 14 Old Queen Street, London SW1.

Indexing Welder for Light Industries

An indexing welder the PAGM 10, suitable for spot or projection welding or hot riveting of small components such as small electrical parts, electrical contacts, transistors, etc., is announced by Sciaky Electric Welding Machines Limited, Slough.

The table of the machine can be fitted with any reasonable number of jigs or stations. Driving and indexing is motorized to provide, through a gearbox, a range of speeds up to 50 per min. The air operated pressure head is fitted with a damper to stimulate shock on the down stroke, this being interlocked with the general mechanism, so that the gear is in the clear position when the table indexes.

The welding current supply and control is made in accordance with the work to be accomplished. Due to the fact that the work is usually small and therefore the welding sensitive, an ignitron contactor is employed together with electronic timing, usually of a synchronous nature. Various types of unloading mechanism, electrical, mechanical or pneumatic, or a combination are used, depending on the nature of the job and this model can be supplied with magazine loading. The machine has an upper rating of approximately 100 kVA.

Anodic Coatings

Conventional anodizing, which is primarily a decorative form of finish, is a cheap and well-known process. The formation of a thicker, more durable anodic coating presents many practical difficulties, but hard anodizing is now an established commercial process and extends the design applications of light alloys in many engineering fields

TWO distinct forms of anodizing of aluminium and aluminium alloys are now practised on a commercial scale. Conventional anodizing is a decorative (and protective) finish in which the coating thickness is of the order of 0·00001 to 0·00002 in. Hard anodizing or 'deep' anodizing is concerned with the formation of coatings of the order of 0·002 to 0·003 in. thick to produce a very hard, durable surface on wearing parts and thus enable aluminium alloys to be used for components where, hitherto, the mechanical wear properties of the metal have proved unsuitable but where other factors are favourable. As typical examples, hard anodized aluminium alloys have been used successfully for engine cylinders, hydraulic and pneumatic cylinders and pistons, servo valves, pumps and even gear teeth, cams and turbine blades.

Both forms of anodizing involve converting the aluminium surface into hard aluminium oxide by electrolytic processing, making the aluminium the anode in a suitable electrolyte and applying the required potential. The oxide film varies in thickness, colour and hardness according to the alloy and the process, in particular the potential applied.

The range of suitable electrolytes for conventional anodizing includes sulphuric acid, chromic acid and oxalic acid. The former is almost invariably preferred for industrial processing, the bath operating at a potential of 12 volts and a temperature of 72–75° F. The sulphuric acid process produces a thicker film than the chromic acid bath, although the latter film is harder.

Following the anodic treatment articles are sealed by immersion in boiling water or a hot solution of a very weak acid salt, effectively to disperse finely divided hydroxide in the pores of the coating. Colouring, where required, is produced before sealing by immersion of the anodized article in a suitable acid dye, a wide range of colours being available although certain colours may tend to lack permanence, and with certain alloys (e.g. casting alloys containing silicon) uniform colouring is not practicable. Quite a number of difficulties associated with the colouring of decorative anodized finishes have been overcome during recent years, giving rise to a much greater range of colours available.

Because of the known hardness and durability of the oxide coating formed during the process, the possibility of building up a thick coating for high wear and abrasion resistance has always been attractive, and a fruitful field for research. Not until recent years, however, has it proved possible to develop 'deep' anodizing to the state of being a definite commercial proposition.

A primary problem was that the type of anodic coating produced varies so widely with the conditions under which it is produced, ranging from loose, powdery coatings, hard or soft, brittle or semi-flexible, to mechanically stable coatings of good strength; and with colour ranging from transparent to dark. Typically, a satisfactory hard anodized coating is dark and compact, produced by high current densities and cold electrolytes—the latter being necessary to keep the resistance of the bath low so that thick films can be built up.

The effect of heat build-up on the anode is to produce a powdery or patchy coating, this being obviated in decorative anodizing by using air agitation to remove the heat generated at the anode surface. Air agitation is employed to circulate the electrolyte so that it has a definite flow rate past the anode in a vertical direction, no airflow actually being allowed to contact the anode surface where it would act as a heat dam and counter the cooling effect of circulation.

With decorative anodizing a vertical (electrolyte) flow rate of the order of two feet per minute is generally adequate to ensure satisfactory cooling. For hard anodizing it has been established that this must be increased to the order of 70 ft per min per foot of anode surface (measured in the direction of flow), and with sufficient volume of electrolyte present to maintain a temperature differential over the extreme ends of the anode of not more than 2° C.

Small subjects of generous cross section require less exacting operation of the bath, although if any overheating is allowed to take place the ends of the anode may be burnt. Thin sections, particularly thin sheets, tend to burn readily at the corners and even right through in the centre, without adequate cooling. Thus a commercial process must be designed to accommodate the extreme cases, and their limitations.

The type of alloy also has a significant effect on the bath requirements. Casting alloys containing silicon usually require very high current densities. Certain alloys may tend to form a 'passive' coating, inhibiting further deposition of oxide coating, in which case combined direct and alternating currents may have to be applied to the bath. In general, however, hard anodizing is done with direct currents and current densities up to the order of 200 amp per sq ft. All the wrought aluminium alloys can be hard anodized and most of the casting alloys (including those containing substantial proportions of copper, silicon and magnesium).

Coating thickness varies with the type of subject, and the alloy concerned. The actual surface finish is rougher than that of the parent metal by an appreciable amount, being most marked in the case of castings or extrusions. It can be finished to any particular specification by grinding, honing and lapping, as necessary, and where this further work is called for the stock removal to produce the finest finish is of the order of 0·0005 in.

A working thickness of 0·001 to 0·0015 in. of hard coating is generally considered adequate for wear resistance, etc., although a higher value is usually preferred. Where subsequent finishing is required, therefore, the usual build-up is of the order of 0·0025 to 0·003 in. In the case of components which cannot readily be ground or honed after anodizing the build-up is restricted to 0·001 to 0·0015 in. Where sharp edges are involved, as in screw threads, etc., a maximum hard coating thickness of 0·001 in. is usually advisable to limit the tendency for the coating to peel at the edges, this being a marked property of the thicker films. Where possible all components intended for hard anodizing should be designed with generous edge radii.

The process has, of course, its limitations, but is now sufficiently well advanced to be an attractive proposition to designers in the utilization of aluminium alloys for components subjected to hard wear, and where the other properties or characteristics of light alloys are particularly attractive.

Development Facilities for the Match Industry

Centralized engineering services for the British Match Corporation

THE consumption of matches in the United Kingdom has remained remarkably stable over the past few years, though of the total 17½ million gross boxes a year the 11½ million gross produced by the British Match Corporation does represent a marked decline with a proportionate increase in the sale of imported matches. This growth of foreign competition in the home market has meant that British match production has had to be considerably reduced and today there are only six match factories against 11 in 1952. The main handicap to the British manufacturer of course is the lack of cheap home-grown timber and the rising cost of imported timber. In the overseas markets the position is much healthier and though the export of British matches is a mere ½ million gross boxes per annum the establishment of subsidiary and associated companies by the British Match Corporation in Canada, Australia, New Zealand, South Africa and some South American countries has increased overseas sales from 17 million gross in 1936 to 31 million gross in 1956.

In spite of the difficulty of timber supplies the British Match Corporation believes that it can maintain a healthy home industry, and moreover considers it to be in the national interest, not merely because of consumer preferences but also because it has proved to be virtually the only source of supply in times of national emergency. In effect, the home and overseas interests of British Match may be regarded as parts of one undertaking, the home industry being the headquarters for all the companies in the group.

To bear out this policy within the industry, new and improved machinery and methods are being employed by British Match which is now in the midst of a five-year modernization programme. An important stage of the plan for the Bryant & May factories at London, Liverpool and Glasgow has been the recent completion of the Central Engineering Works at the company's Fairfield Works, Bow, London E3. As the name implies it will provide excellent centralized machine shop facilities for the maintenance and construction of specialized plant for the three factories. But of far greater importance will be provision of facilities for engineering research and development for the associated and subsidiary companies of British Match both here and overseas which is essential for the expansion of overseas markets. In this respect it should

A general view of the machine shop of the Bryant & May Central Engineering Works at Bow, London. The fitting shop, which is equally large, is on the other side of the office and stores area on the left of the illustration

be mentioned that all companies through the parent company derive the benefit of an agreement drawn up between the British Match Corporation and Swedish Match Company to collaborate in the technique of match manufacture.

The machine shop and fitting shop occupy 15,000 sq ft floor space and there is also space for electric and gas welding, heat treatment, inspection and stores. It is also planned to hold a complete range of spares for all factories.

A large range of new machines is now in use on precision engineering work in the turning, milling, planer and shaper, boring and drilling, grinding and press sections. Delivery is also expected soon of a Keller copy milling machine and an S.I.P. Hydroptic 6a jig boring and milling machine. There is also a full complement of the usual inspection and ancillary equipment, including a range of mechanical handling equipment. Two overhead travelling cranes provide lift of up to 5 ton to all parts of the fitting shop and up to 3 ton to all parts of the machine shop.

Ceramic Cutting Tools

Probably the most interesting recent development is the ceramic cutting tool for cutting steel, which was first put on the market early in 1956. There is still considerable speculation as to the value and importance of this new range of tools and practical tests indicate promising performance. Some data regarding these tools are given in the following notes

ORIGINALLY of American origin, these tools are composed primarily of aluminium oxide, and have some relation to carbide tools in that they are a sintered product, given their ultimate form by pressing and sintering. The crystalline oxide gives exceptional hardness, high compressive strength and low thermal conductivity, a superior tensile strength and excellent dielectric properties. There is a degree of brittleness, but the extreme hardness of the cutting edges enables the tools to go on cutting even at exceptionally high speeds, while the resistance of the hard material to wear enables it to withstand to a remarkable degree the severe abrasion of non-metallics such as plastics, and of graphite.

In one large automobile manufacturing company, considerable application of these tools has already been made and further developments are under review. The finish-machining of standard transmission sliding gears with these tools is claimed to have produced a 26·5% reduction in cost per gear. The work involves finish turning, grooving and facing the part on an automatic lathe. The material is forged steel with a Brinell of 170–207, and the part is approximately 10 cm dia.

Five cutting tools are employed, three of ceramic and two of carbide. The carbides are used only because in this instance the ceramics could not be clamped sufficiently to cut a narrow groove on the work, and because the other carbide tool had to drag across the work, for which the ceramic tool would have been unsuitable, owing to the reduction in its working life if so used. The ceramics operated at 310 surface metres per min, with a feed rate of 0·04 cm/rev and a 0·03 cm cut depth. Cycle time with carbide was 0·25 min and has now been reduced to 0·18 min. No coolant is employed.

Another user turns bearing sleeves for milling-machine arbors with ceramic tool bits on a production basis. The sleeves are of cold drawn steel tubing. This firm claims for the ceramics that they need rigidity in the machine, particularly at the toolholders. The geometry of the cutting edge is important, and the most effective cutting is obtained when the clamp holders resemble those employed for carbide bits. The work must also be firmly supported on account of the high pressures and speeds. Skill is essential in the operators as the ceramics can be spoiled if taken into the cut too quickly, causing shock loading. Nevertheless, fairly heavy cuts can be taken.

Another user has found that clamped tools are required, while carbide shims are advantageous in supporting the ceramic bit. The speeds used by this firm range from 120 to 420 surface metres per min. On certain materials the cutting speeds may go even up to 900 surface metres per min. The cut depth varies from a light finishing cut of 0·03 cm to as much as 0·76 cm.

A firm making agricultural machinery has run tests of ceramic tools against the carbides. It has been found that with the ceramics, speeds above 360 surface metres per min occasion severe damage to the cutting edges. Speeds below 120 surface metres produce a rubbing rather than cutting. On the other hand, the ceramics have a considerably longer tool life than the carbides. The material used was a hot-rolled steel with a Brinell of 180–190.

A machine tool manufacturing company has decided that these tools have great potential use in plants where work has to be turned at high speeds and to close tolerances, but they consider that a great deal of development work must be done before the ceramics equal the carbides. The machines will have to have higher power and speed to realize the economies these new tools render possible. They have proved to their own satisfaction that ceramic tools will cut at much higher speeds than can be achieved economically by the carbides, but they must not be used at the maximum possible speeds or tool life will be lessened.

Another machine-tool manufacturer states that in general, and particularly when loads are light, these tools give a good wear pattern. Their edge strength adequately carries the chip load and wear depends mainly on abrasion. The tools are not found satisfactory where heavy scale has to be cut through or for intermittent cutting, as this causes chatter and breakdown of the cutting edge. This is also true of heavy loads causing chatter.

Nevertheless, each of the firms mentioned believes that there is definitely a field of use for the new tools, which will do more than any other types of cutting tools in a large number of applications.

What exactly is claimed for these tools by their manufacturers? Briefly it is that they will cut metal from two to four times as fast as the best tool materials in use at the present time. They will cut heat-treated parts too hard for the carbides. They are said to last up to 25 times as long as carbides, to give superior finish, and to be capable of cutting without the need for a coolant. As against this, it is admitted that fracture of the tools is frequent, particularly at the start of cutting where the impact of the brittle ceramic against the work is high. Intermittent cutting, as in the faces of irregular pieces, is causing difficulty, but in Czecho-Slovakia success has been reported in turning cast iron diesel pistons pierced with holes for wrist pins. Cost at the moment is considerably higher than for carbides.

We must remember, however, that the ceramics do not, as do the high speed steel and carbide tools, need critically scarce materials such as tungsten, tantalum, cobalt and nickel. In addition to aluminium oxide, the tools are believed to contain silicon oxide, magnesium oxide and bonding materials. The tool bits made from the oxide are highly resistant to abrasion and erosion, and their other properties have already been stated. Development work is proceeding, and is largely concentrated on the bonding materials, which to a considerable extent determine the degree of brittleness. It is hoped ultimately to produce a bond that will keep the hardness of the material as well as its compressive strength, while giving it a greater tenacity.

The bending strength of the tools is much below that of the carbides, but the hardness and strength at elevated temperatures is much higher. Thermal conductivity is below that of the carbides, which means that uneven heating may result in cracks and shattering. In this lies one of the reasons why cutting is usually carried out without a coolant, which would by its chilling effect cause the fluctuations in temperature harmful to the bit material.

Brazing on of the tip by normal methods may also be troublesome if unequal heating occurs, but glass 'solders' or fired-on metals have been employed in Europe. Epoxy resins are believed to hold out promise by reason of the low thermal conductivity of the ceramic.

Because there is this danger of fracture owing to the brittleness of the oxide, the tool holder has to be designed for minimum mechanical stress (e.g. bending) and to prevent stress concentrations caused by too small areas of contact surface. A method of achieving this is to use the carbide shim as support and clamp the bit with a band, strap or rigid bar. The holder must also be so designed that it is not harmed if a tip should fracture.

At low temperatures the ceramic material has poor strength, whereas at high temperatures its strength is good. In consequence, cutting without the aid of a coolant is no drawback, and is therefore usually adopted. The ceramic bit definitely cuts better than the carbides at high temperatures, and therefore if the machine-tool maker can build a machine that will withstand the high temperatures involved, there is no reason why these tools should not run at their best temperatures, and if any cutting fluid at all is used, it will be for the protection of the work rather than of the tool.

The ceramic tools do not absorb heat to the same degree as other tools, so that the tip remains quite cool to the touch even after it has taken a heavy cut. Moreover, the chip does not weld to the tip because the tip is non-metallic and also because the cutting speeds are too high.

Ceramic tools have been the subject of experiment over a period of fifteen or sixteen years, and while it is true that the first metal-cutting ceramic tools came from the United States, it must not be forgotten that ceramic tools were first successfully used by an English firm, which employed them for cutting plastic materials soon after the Second World War, during which the first experiments were carried out. In 1954 a British firm actually put ceramic tool bits on the market, but later abandoned them on the grounds that they were not yet satisfactory for steel. Now, another large British firm has put ceramic tools for cutting metals on the market once more.

But some authorities hold that the U.S.S.R. preceded even the Americans in developing satisfactory ceramic cutting tool bits, having used a minimum of seven different types since 1954, while intensive development is known to have been in progress there since 1947. Ceramics are mentioned increasingly in reports from Czecho-Slovakia, and it is known that their ceramic tools are being sold to France.

In the United States there are now six firms developing these tools, but so far only four have actually put them on the market. They are regarded not so much as replacements for the other tool materials as additions to the wide range of cutting tool materials. Most of the experiments have been carried out using lathes, by reason of the character of the ceramic material. The greatest advantages are reaped from these tools when they can be employed at high speed, with heavy cuts and at low shock. Few experiments have so far been tried using alternative machine tools, and it seems clear that predominantly these materials are likely to find their greatest application in the field of lathe work.

Opinions vary as to the potentialities of these tools, some considering that they will only come in for work other tools will not do, others that they will be widely employed in view of the growing increase in automation. Thus, minutes sacrificed during the replacement of tools become a most damaging item of cost when a part is being produced automatically, and the use of ceramic tools may greatly reduce this down-time.

It may be recalled that nearly twenty years were required for the machine tool makers to make machine tools rigid and powerful enough to cope with the vastly increased speeds rendered possibly by tunsten carbide. It is considered quite possible that a time-lag may occur with the ceramic tools, while the inevitable conservatism of industry must also be taken into account.

The English ceramic tools have been tested in comparison with carbide tools, and whereas on bright bar, running at a feed of 0·025 in. and a cut depth of 0·125 in., on a bright bar 6¾ in. dia by 27½ in. long, the carbide tool showed flank wear of 0·020 in. with a crater measuring 0·045 in., the ceramic tool showed a flank wear of only 0·005 in. Both tools ran at 500 ft per min. On black bar, the feed was 0·020 in., cut depth 0·1 to 0·25 in., the bar measuring 7¼ in. by 28 in. long. Here the ceramic tool, running at 160 ft per min showed negligible flank wear, whereas the carbide tool showed 0·005 in. flank wear. When a bright bar 6½ in. dia by 27½ in. long was machined at the same feed and cut depth as in the first performance mentioned, but at a speed of 700 ft per min, the ceramic tool showed wear on the flank of only 0·006 in. whereas the carbide tool broke down and the test had to be discontinued for fear of its collapse.

The ceramic tools are best dry ground with diamond wheels, using metal-bonded diamond cup wheels as for carbide tools; 150 grit is recommended for shaping or roughing and 320 grit for finishing.

[Other recent articles on ceramic tools are:

"Ceramic Cutting Tool Materials" (Soderfors). May, 1957, p. 228.

"Properties and Performance of Ceramic Cutting Tools" (English Steel Company Limited). June, 1957, p. 268.

"Equipment for Cemented Oxide Tools Research" (Wickman Limited). March, 1958, p. 114.]

technique

devoted to the discussion of practical problems. Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance. Payment will be made for published contributions.

Any Questions ? We welcome inquiries concerning difficulties arising out of our readers' general work, for treatment in the **technique** section. The full name and address of the writer (not necessarily for publication) must accompany each communication

Counting Switch

A spring return limit switch for use in mine car circuits, to eliminate the need for counting relays, has been designed by Mr. R. Hathaway, Area Chief Electrical Engineer in the North Eastern Division, and has been used with success in that division.

The switch is operated by an arm fitted with a roller which is depressed by the passage of a mine car and is suitable for mounting in the track for direct operation by the car wheels. Alternatively, each of several projections on a passing car may be arranged to cause the arm to depress. The purpose of this device is to ensure that only one of a given number of such depressions actuates the switch mechanism. It can thus be arranged that the switch will allow a predetermined number of cars to pass before operating.

The number of depressions of the roller arm for each operation of the switch is decided by a combination of the number of lugs provided on a ratchet-operated disc in the mechanism, and by the arrangement of the insulating arms which actually depress the switch mechanism.

Fig. 1 is a section of the box containing the mechanism, showing the arrangement of the ratchet. The shaft 1 is carried right through the box, and at its outer end is attached to the roller arm. Each depression of this arm causes the spring-loaded pawl to jump over one of the cylindrical lugs 4 in the disc 3. Although four of these lugs are shown in the drawing, their number can be varied to suit the predetermined number of depressions of the arm required to operate the switch. When the roller arm returns to its original position under the action of the spring 5, the disc 3 is rotated by the ratchet action through part of a revolution. This movement also rotates the shaft 6 upon which the disc is mounted.

Fig. 2 is another section through the box, showing the arm which actually depresses the switch. In this instance the arm consists of a laminated bakelized sheet carried on the shaft 6 which was noted under Fig. 1. The switch is only operated when the sheet is in the position shown; movement of the sheet to the dotted position, under the ratchet action, neutralizes the action of the roller arm, and in this position depression of the arm does not actuate the switch.

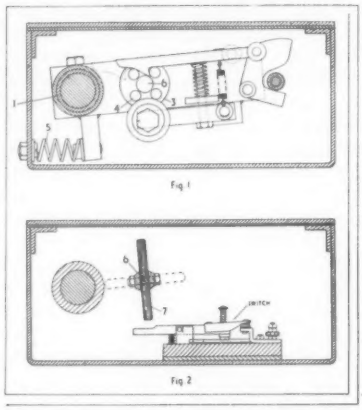


Fig. 1. Section showing the ratchet mechanism of a spring return limit switch. Fig. 2. Section showing the laminated disc which operates the switch.

Fig. 2 shows an arrangement under which the switch is operated for every half revolution of the shaft 6. The design can be modified by removing one half of the laminated sheet, and the switch then operates once in every complete revolution of the shaft 6.

In the arrangement illustrated, the switch will operate at every other depression of the roller arm; if the modifications discusssed above are introduced, i.e. six lugs on the disc 3, and removal of half the laminated sheet 6, six movements of the arm are needed before the switch is actuated. Other combinations can be introduced to suit specific requirements.

Welding a Stack for an Oil Refinery

Designed for use in an oil refinery, a 120 ft mild steel stack is being fabricated by Alfred Allen & Son Limited of Lower Gornal, near Wolverhampton. The stack is being manufactured in sections, which are welded and flanged. The flanged sections will be bolted together on the site.

External welding on the stack is carried out by the Fusarc/CO_2 process. The welding head is mounted on a cross-traverse cantilever, and the stack sections are rotated beneath it on a roller bed which is capable of accommodating vessels from 1 ft to 10 ft 6 in. dia, and comprises both drive and idler units. The cross-traverse cantilever enables the welding head to be traversed along the vessel for longitudinal seams, and to be positioned correctly so that the vessel can be rotated for the deposition of circumferential seams.

With the Fusarc/CO_2 process, a specially-designed continuous coated electrode is deposited under a shielding atmosphere of carbon dioxide gas. The electrode, which is of the rutile type, ensures good welding conditions, with a stable arc and minimum spatter. The electrode is baked to reduce its potential hydrogen content. The CO_2 envelope, chiefly by reducing the partial pressure of hydrogen in the arc atmosphere, ensures that the deposited metal is of the quality associated with low-hydrogen electrodes. Welding speeds are high, and for the first time it is possible to deposit high-quality welds automatically in the horizontal-vertical position using the open-arc process.

Welding of the stack sections takes place at a welding speed of 30 in. per min, with a current of 680 amp. Current is supplied by a Quasi-Arc 750 amp generator. No edge preparation is used, and the electrode is Fusarc/CO_2 No. 1.

For fabrications of this nature, Messrs. Alfred Allen have used the

Stack in place on welding machine, the roller bed of which can accommodate vessels from 1 ft to 10 ft 6 in. dia

system of chipping-back the inside of the joint and applying a sealing run with Radian electrodes. In view of the high weld quality and controlled penetration obtainable with the Fusarc/CO_2 process, it was decided that the chipping-back operation could be dispensed with.

Tests were carried out under strict radiographic control with Weldeep electrodes and it was established that these electrodes obviated the need for chipping-back and gave excellent interpenetration. The new method has not resulted in any loss of quality, even where butt welds meet in a T-junction. The method has also resulted in a significant decrease in overall time, with a consequent improvement in both labour and overhead costs.

Cutting Positioned Teeth on a Reel

Fig. 1 illustrates a large reel type of workpiece which required spur teeth on each of the two outer diameters, and to further complicate matters an essential part of the design was to see that they matched each other when finally cut—positioned teeth as they are commonly known in the workshops, and because of their size and importance a Maag gear cutter was chosen for this work.

Components cut on these machines are generally set rather high from the table surface to allow the tool box to clear, and for this reason the fixture seen at Fig. 2 was designed, but with a view to performing both operations on the same piece of equipment. Fabrication was also adopted in an endeavour to reduce the pattern making charges, and as the fixture was circular it meant that black bar with little or no previous preparation was used in the construction. However, to assist the welder in obtaining a proper joint, the corners were angled in the usual manner to allow a satisfactory build-up of the welding material.

The Maag machine had a tapered locator in the table for securing the position of fixtures bolted to that member, and this detail was extended to make a substantial and accurate spigot for that purpose. Fig 2 shows this, and use was also made of the bush at the bottom of the table hole for the clamping bolt necessary for holding these gears. This bolt passes up through the component locating plug and is entirely separate from the remainder of the fixture.

The locating spigot B is hardened and driven into the base A and held securely by three screws set in the upper flange. Making the spigot in this manner, combined with a long bolt, allows the replacement of the spigot for different components; thus one base is often suitable for several gears.

The locating plugs were ground after heat treatment and particular attention was given to concentricity to ensure that they positioned the gears truly with the underneath spigot of the machine table. To save frequent removal of the fixture from the machine table, jacking holes were incorporated. As these screws would easily damage the top surface of the fabricated base if continually used, a shallow groove was turned in the base against which the screw ends could bear; this meant that the floor of the groove could become damaged and be of no consequence, while the upper locating face remained smooth ready to receive any number of locating spigots. In the bottom of the base A another bush D—again hardened to resist wear, and this ensured that frequent lifting on and off the machine did not cause the locating hole in the base to become unduly worn or elongated.

This detail is not essential if the fixture is to remain on the machine table for long periods as the table locating plug can push straight into the base, but with 'standard' fixtures

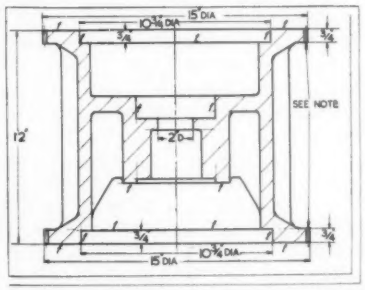


Fig. 1. Cross section through the component showing the longitudinal ribs for strengthening the part due to the comparatively thin walls. Note, underside of teeth is not machined. The gear is finish machined at 'f'

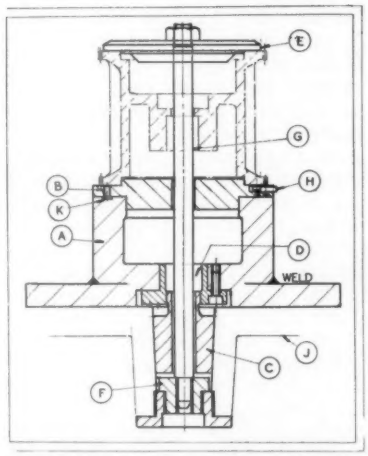


Fig. 2. Fabricated fixture for cutting the teeth illustrating the removable insert which position the teeth in the second operation. A, fabricated steel base. B, locating spigot. C, table spigot. D, bush in base locating on table spigot. E, clamping plate. F, lower bushes for stud. G, stud. H, tooth locating detail. J, machine table. K, turned groove prevents damage to top face of fixture

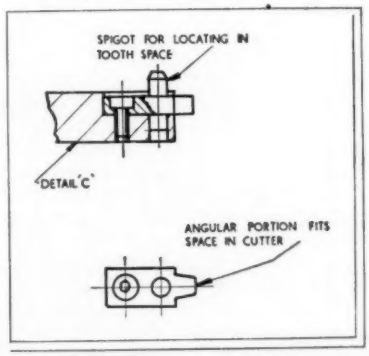


Fig. 3. An enlarged view of insert which has a spigot on the base for location in the fixture, and a pin on the upper surface which engages in a tooth space

where the base is set up many times during the course of a week, the inclusion of this hardened bush is generally an asset and worth the extra expense and time taken in inserting it. In the drawing three screws hold it in place as a precaution against it dropping out as the fixture is lifted.

The fact that bush C engaged with the tapered hole was enough to secure a tight fit and true location.

Beneath this item was the small assembly for holding the long stud that passed up through all the details and finally held the component to the top face of the locating spigot. This assembly F built-up in two pieces—a screwed item which fitted the machine table and another bush for the stud; and though this may appear rather an elaborate method, with the aid of a special spanner provided it was an easy matter to remove the bush and replace it with another having a different diameter thread for some other component.

Positioned teeth seldom present many serious problems if attention is paid to accuracy during the initial stages of cutting the teeth—a careful check on the pitch line is obvious and a subsequent location from this point ensures that other teeth cut in relation to the first set are then correctly aligned. It thus becomes apparent that a tooth locator is essential, and on this occasion item H had the dual function of locating the gear and also provided a means of setting the cutter. Each component was therefore loaded on the main spigot and the extension pin seen at Fig. 3 on this tooth locator engaged with a tooth space—the position being accurately calculated and the hole in the plate B jig bored to give the final position of the tooth pin where it engaged on the flanks of a tooth.

The outer edge of plate H was shaped to an angle corresponding to the pressure angle of the gear; thus on lowering the cutter it was possible to engage it with a tooth space, and this means that the tool was always set to a tooth space and so positioning of the teeth was achieved.

The setting piece was below the actual site where the teeth were cut, and after setting the cutter with the dummy tooth, the machine slide was adjusted to raise the tool several inches to the cutting position immediately beneath the clamp holding the gear. Incidentally, the latter item was merely a flat circular disc on which was machined a diameter a hundredth or so smaller than the recess in the components for centralizing the clamp, and the outside diameter was turned to clear the root of the teeth.

A further point not apparent on the assembly drawing is the positive location of the lower plate B on the base—an essential feature as there was always a possibility the vibration set up by the cutter moving the plate and tooth locator, so the use of a dowel was necessary to ensure that no radial movement took place. The bolts securing the fixture to the machine table were equally spaced slots round the base.—**J. A. Waller.**

Taper and Spherical Boring Large Containers

The set-up described below was employed, and the appropriate parts made, to meet the requirements of a customer's order for a number of large cast iron container sleeves. The container sleeves were in halves and measured 6 ft 2 in. long, 20 in. outside diameter, 14½ in. in the bore, tapered to 14½ in. plus 0.006 in. on diameter in 6 ft. An additional requirement was the formation of the spherical seating seen at Fig. 1, which shows the container sleeve A in half section. It was held in the chuck jaws and supported at the opposite end in a revolving sleeve running in a heavy bracket.

To avoid a confusion of lines, the bracket and sleeve are not shown in place in Fig. 1. They are seen in small scale in Figs. 3, 4 and 5. Since the container sleeves A were in halves, the revolving sleeve B, Figs. 3, 4 and 5, was made large enough in the bore to take the flanges at A, Fig. 2, at the parting. Revolving sleeve B seen in plan in Fig. 4, is furnished with a large diameter part at its middle portion to provide the necessary thickness of threaded metal for the adjusting screws C, Fig. 3. The square headed screws C were adjusted by hand spanner when truing the job.

Fig. 5 is a half section view of the end support bracket assembly of Fig. 3, along with one top half cover D, one of which is mounted on either side of the large diameter part of the revolving sleeve B. The boring bar E, Fig. 1, was 9½ in. dia; it was centred at the chuck end and rigidly held at the tailstock end in a robust split bearing bracket F. For the boring operation the tailstock was removed, the boring bar was stationary and the job revolved. The boring bar E was machined out from end to end to take a dovetail tool-holder G seen in end view at Fig. 2.

The tool-holder path is machined in the bar to the correct taper of 0.006 in. in 6 ft. The cut through the container sleeve A, Fig. 1, was started from the chuck end and the tool was fed along by means of a pull rod H, made fast to the tool-holder G at one end and the tool-slide I on the lathe carriage, at the

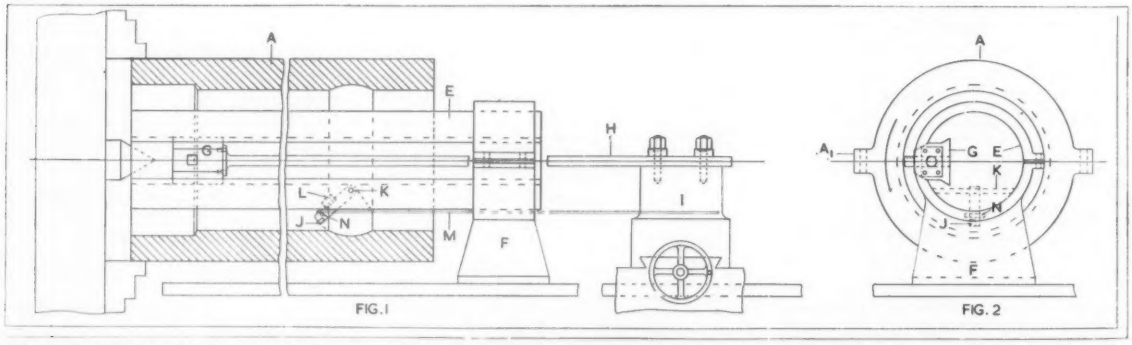


Fig. 1. Container sleeve in half section showing taper boring bar E and spherical toolholder and cutting tool J in action. Fig. 2. End elevation showing taper tool-holder G with pull rod H attached. Also split bearing bracket F holding boring bar E stationary

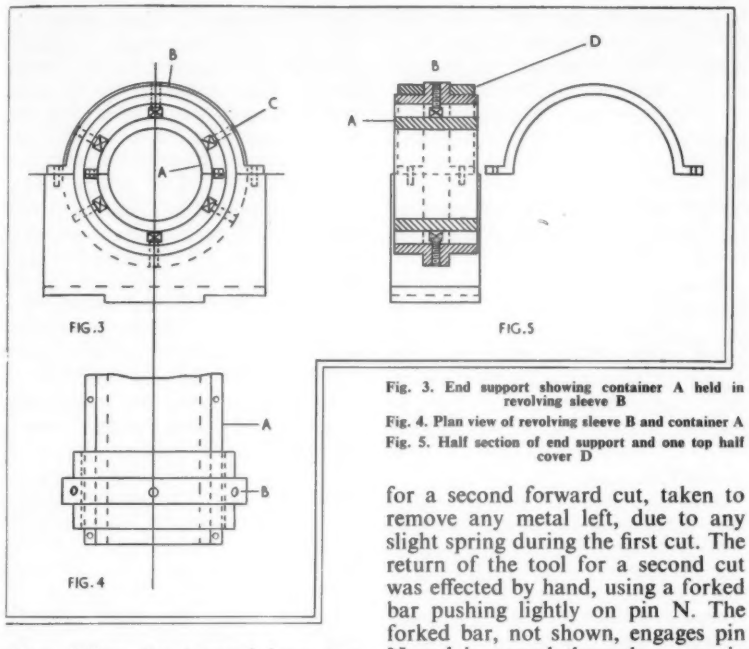


Fig. 3. End support showing container A held in revolving sleeve B

Fig. 4. Plan view of revolving sleeve B and container A

Fig. 5. Half section of end support and one top half cover D

other. When the tapered bore was completed, the spherical seating was formed by tool J. The tool-holder carrying the cutting tool J is located in a slot formed in the underside of the boring bar E. It is suspended from pin K and is held in the off position by a heavily magnetized insert L. The tool-holder is a close working fit in the appropriate slot.

The spherical seating was formed in two cuts, with the pre-set tool operated by a pull-wire M, looped around the tool-holder and attached to the tool-slide I. Pin N serves to keep pull-wire M in position during the cut, and is used to return the cutting tool to the starting point for a second forward cut, taken to remove any metal left, due to any slight spring during the first cut. The return of the tool for a second cut was effected by hand, using a forked bar pushing lightly on pin N. The forked bar, not shown, engages pin N and is passed through a core in bracket F. When machining the tapered bore and the spherical seating, the whole range of the lathe carriage feeds was available. The cutting tool J, for the spherical seating, was a carbide insert. To prevent it suffering damage from falling on the bore when released from the magnet by pull-wire M, a length of lead strip about $\frac{1}{4}$ in. thick was passed into the bore to take the impact. The tool was then carefully pushed backwards, clear of the lead strip, which was withdrawn, and the tool gently lowered to start the cut.

—**M. Donald.**

Lubrication of Paper Machines

In any paper mill the paper machine is the prime piece of equipment and the output of the plant is thus dependent upon its continuing to run at optimum efficiency. Maximum production is required from both old and new machines and a properly engineered lubrication system is necessary to ensure the economical running of very valuable plant.

On the dryer section of a modern paper machine, fitted with high quality bearings, running under heavy loads and at elevated temperatures, the problem of lubrication presents a considerable challenge. Experience shows that the most practicable method is to supply the bearings with clean oil at controlled temperature, pressure and volume; the volume being such that a rapid change of oil in the bearing is accomplished thus ensuring an effective cooling and flushing action.

Where the dryer cylinder gearing is totally enclosed, this is best lubricated by means of sprays injecting the oil direct into the mesh points of the gears. The sumps of the gear cases should be run 'dry', thus avoiding the powder loss due to fluid friction which occurs with bath lubrication. In certain gear boxes this power loss has been found to be as high as 30%.

It is of course obvious that the above methods imply a fairly high flow rate and can be effective and economical only when the bearings, their housings and the gear cases are properly designed, and also when the oil is reconditioned and recirculated.

With regard to the former point, adequate oil ways must be provided to allow free passage of the lubricant and efficient seals must be fitted to prevent, as far as possible, oil losses and the ingress of foreign matter.

In the latter case, reconditioning must be carried out within the lubrication system itself.

It also follows that, since the efficient running of the paper machine is dependent to such a very great extent upon the lubrication system, this system must be carefully engineered in order that it may be completely reliable and operated automatically with the minimum of attention.

The main components of the system are:

(a) A large capacity reservoir tank which must allow for a settling period of at least 40 min (e.g. if the circulation rate of the system is 50 gpm then the reservoir tank should have a capacity of 2000 gal). This settling period permits the precipitation by gravity to the base of the tank of any foreign matter such as water and paper dust which may have been picked up by the oil. The tank may be fitted with primary filter screens to arrest the larger contaminants and also with baffles to divert the flow through the tank.

Steam or electric heaters, automatically controlled, should be incorporated in the tank in order that the contents may be heated to decrease the oil viscosity and accelerate the settling process.

In some cases, where high water contamination is encountered centrifugal separators can be employed with advantage. They can then also assist with solid contaminant separation.

(b) The supply pump, normally of the positive displacement type, draws from the reservoir tank through a floating suction which takes oil from the relatively clean upper layers in the tank. A stand-by pump is usually fitted which, by means of pressure switch control, is brought into service automatically in the event of failure of the service pump to maintain the required system pressure.

(c) It is now commonly accepted that more effective filtration can be obtained by pressure filters than by the gravity types formerly used. The

pressure filters are fitted in the discharge side of the pump and can be arranged to eliminate very fine particles of contaminant down to micronic sizes. The more efficient the filter the larger and more expensive it must be and it is necessary to arrive at reasonable compromise.

(d) An air loaded pressure vessel is included in the pump discharge lines to even out any pulsations in the oil supply, provide a suitable medium for the pressure switches controlling the pumps as well as a small reservoir of pressurized oil in event of total failure of the pumps.

(e) It is essential that the oil be supplied to the bearings or gears at a constant and predetermined viscosity and this is achieved by the use of an oil cooler, automatically controlled, which will maintain the oil supply at a constant temperature usually about 100° F. If the reservoir tank is to be run at an elevated temperature to facilitate precipitation or centrifuging, then the cooler must be of sufficiently large capacity to cool the full circulating quantity of oil from that temperature, which may be as high as 180° F, down to 100° F.

(f) In order to ensure that correct quantity of lubricant is supplied to the various points on the machine, flow control valves or metering orifices are fitted, as well as pressure regulators to maintain a constant pressure at these devices.

Pressure switches and low flow indicators are fitted at key points in the system to give audible and visual alarm of lack of lubrication. These devices can be interlocked with the main drive motors to prevent these being started before the lubrication system is operating effectively.

Such a system is a fairly costly item and must necessarily occupy a fair amount of space, but its cost represents a very small proportion of the capital value of the plant it is designed to protect.—**D. F. Craig, B.Eng., Chief Engineer, Liquid Systems Limited, Croydon.**

Welding and Erecting Large Stainless Steel Vessel

A nitric acid absorption tower which is now in service at the Wilton works of Imperial Chemical Industries, is said to be one of the largest stainless steel vessels ever to be welded. Weighing 93 tons, it has an overall length of 139 ft and a diameter of 15 ft. It was fabricated by Ashmore, Benson, Pease and Company of Stockton-on-Tees, and the material used throughout was 18/18/1 austenitic steel. The shell was made in three distinct sections of differing plate thicknesses.

For the lower part, measuring 14 ft 9 in., material of $\frac{5}{8}$ in. thickness was used: the centre and the remainder was a $\frac{3}{8}$ in. thick material. The hemisphere forming one end (this became the top of the vessel when vertically erected) was also in $\frac{3}{8}$ in. thick material and was constructed from 12 segments and a crown. The hemisphere for the other end was constructed in similar fashion to the top hemisphere but with 10 segments and a crown. The thickness of material used was $\frac{5}{8}$ in. and both ends were therefore of the same thickness of material as the section of shell to which they were joined. The supporting base rings and skirt were in $1\frac{1}{2}$ in. and $\frac{3}{4}$ in. thick material respectively.

Fusarc automatic machines, using continuous Staymec No. 1 electrode, were used and fabrication was carried out in a series of sub-assemblies approximately 15 ft long, in order to make the fullest use of the internal welding boom for automatically welding the internal seams. For external welding, a Fusarc welding head mounted on a universal type of cantilever was employed and beneath this the vessel was mounted on a heavy series roller bed, being rotated for the circumferential seams and traversed for the longitudinal seams.

The internal welding boom was of the fixed type and is specifically designed for welding internal longitudinal and, in conjunction with a roller bed, the circumferential seams of vessels with a minimum diameter of 2 ft and up to 15 ft long. It comprises an automatic welding head incorporated in a slender boom at the end of which is a cradle in which the operator lies prone. The boom is supported from the opposite end by a structure in which the boom may be adjusted horizontally and vertically as necessary. A panel in front of the operator gives complete control over the welding and, if necessary, of the welding speed, since the roller bed may be rotated or traversed remotely through push-buttons on the control panel. The welding nozzle protrudes below the cradle and the operator can observe the arc through a dark glass screen let into the base of the trough.

The platform of the universal cantilever is adjustable for welding vessels from 1 ft to 15 ft dia and the welding head can also be traversed outwards by means of a lead screw for a distance of 6 ft 6 in. A hand-operated vertical slide gives additional fine local adjustment.

In a heavy series roller bed also employed, 4-roll units take vessels weighing up to 24 tons and 6-roll units take up to 36 tons. A single handwheel gives simple and rapid centre adjustment of the rolls for vessels between 1 ft and 17 ft dia. Individual units may be motorized both for rotating or traversing the vessel at controlled speeds for the automatic welding of circumferential and longitudinal seams respectively.

In the fabrication of large diameter vessels such as this column, a spider form of internal stiffening is usually fitted to maintain circularity of the vessel. In this case, however, other means had to be adopted so that the internal welding boom could be used. External stiffening rings were therefore used to maintain concentricity while the welding was in progress. These were left on each sub-assembly until internal tray supports in the style of a cruciform had been fitted, after which the external rings could be removed.

Each circumferential tier was made of three plates. All the internal and external longitudinal seams of the shell were welded automatically by a Fusarc welding head, with the exception of the internal mating seams joining the sub-assemblies and the hemispherical ends, which were welded manually.

When the vessel was fully assembled, the stiffening rings which had been previously used in the initial stages of the fabrication again came into use. These were placed around the vessel at predetermined points and at these rings jacking brackets were fitted. The vessel was then raised from the roller bed, and bolster bogies each weighing 10 tons, for transporting the vessel, were placed at calulated positions underneath. The vessel was then lowered on the bogies and secured.

The problem of transporting this unusually-large vessel to the site then had to be solved. A specially-cranked drawbar weighing one ton and giving only 9 in. clearance from the road was manufactured by Ashmore, Benson, Pease and Company Limited for Pickford's who had the task of delivering. An 18-mile journey to the site at Wilton took two-and-a-half days to complete. Three Scammell 50 hp lorries were used at one point to assist in negotiating a hill.

For the erection of the vessel, special lifting links were fitted to a trunnion placed in bearings which were welded to the column.

A number of timber platforms, together with a ladder, were fixed inside the vessel to provide access from the manhole at the base to the platform at the top. A small jib crane was also attached to brackets at the top of the column so that internal parts could be lifted into place later, as required.

The lifting of the column was achieved with two 105 ft high derricks, each equipped with an electrically operated winch and a set of blocks, coupled to the links on the ends of the trunnion. A Lima crane was employed to take the tail end load, the crane travelling towards the foundation block as the column was lifted. The weight was taken on the lifting gear, all the derrick guy anchorages and the concrete foundation block were cleared and the transportation bogies and cradles were removed.

When the column was in a vertical position, it was then lowered on to the foundation block. Together with the setting, the operation took only a few minutes. Twenty-four specially designed $2\frac{1}{4}$ in. dia holding-down bolts which had been placed in position beforehand were then drawn through the base plate and secured. The concrete on which the column was erected was approximately 30 ft square to a depth of 10 ft and 525 tons of concrete were used.

When the alignment was later checked, the column was found to be quite vertical in the north to south direction and to within half-an-inch of vertical in the east to west direction.

Penetration Recorder

An instrument for recording the rate of penetration when boring through coal seams has been devised by Mr. J. A. Chilton, No. 5 area geologist in the NCB East Midlands Division. The purpose is to produce a graph with a continuous curve of depth penetrated against time. Such a curve is of great value while coal seams are actually being penetrated.

The instrument is for use with drilling machines fitted with a hydraulic head. The curve is recorded on a drum driven at a speed of one revolution per hour. The drum is large enough to accommodate a graph three inches high and six inches in circumference; this allows for a graph to be produced to the scale of one inch to ten inches and one inch to ten minutes, with an average rate of penetration of $\frac{1}{2}$ inch per minute. A suitable stylus, such as a ball pen with interchangeable colours, is attached to a vertical slide so that it makes contact with the graph. The stylus is driven by a rack-and-pinion, the pinion being rotated by a spring-loaded drum. This drum is connected by a flexible wire, through a pulley system, to the top of the hydraulic head. Movement of the head revolves the drum, and the stylus is moved by the movement of the pinion on the rack. The diameters of the spring-loaded drum and pinion are arranged to give a one in ten reduction in the movement of the stylus compared with that of the drill. A zeroing device is fitted to the drum to enable the stylus position to be adjusted for different wire lengths.

Try Square Attachment

There are many occasions when a check with a try square is necessary, particularly on the horizontal boring machine or planer, and it may also become essential to stand the square at right angles to the table slots. For this purpose a square is modified by grinding two grooves $\frac{1}{8}$ in. wide by $\frac{1}{16}$ in. deep to hold two blocks as shown. The blocks enter the machine slots with about $\frac{1}{16}$ in. clearance, thus if the block is pressed against the side of a table slot, the square stands at right angles to the direction of travel.

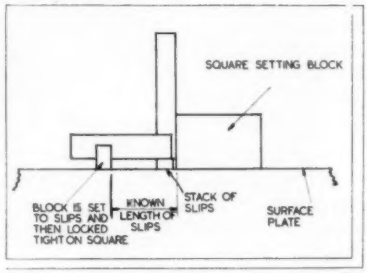


Fig. 1. Try square with block to fit machine table slots. A, standard square. B, blocks locate in slots of machine table. C, socket head screw

Fig. 2. Using slips to set edge of square a required distance from edge of table slot

The device can also be pre-set by means of slips by standing it as shown in Fig. 2, and then clamping the blocks tightly. When offered to the table slot the blade edge then stands a known distance from the edge of the slot. Alternatively it can apply from the edge of a casting and is useful for setting components during assembly. For continuous work the blocks require hardening and a socket head screw is essential for secure fixing.

Non-corrosive Hydraulic Fluid

Glycerine is commonly added to the water used in ships' hydraulic gear to prevent freezing, but a tendency for the solution to develop acidity raises corrosion problems. In Admiralty Bulletin No. 97, Mr. A. A. C. Griffith, Lieut. S. M. Tennent and Mr. D. Wyllie, of the Admiralty Oil Laboratory, discuss various methods which have been tried to neutralise the corrosive effect, and give the composition of the most promising of the fluids tested as: 60 gal glycerine of dynamite quality, 40 gal distilled water, 2 lb sodium nitrite and 8 lb disodium hydrogen phosphate. Experience with this fluid in arresting gear showed some aeration, but this was overcome by reducing the glycerine to 40% (distilled water 60%), thereby reducing the viscosity but not affecting the anti-corrosive properties.

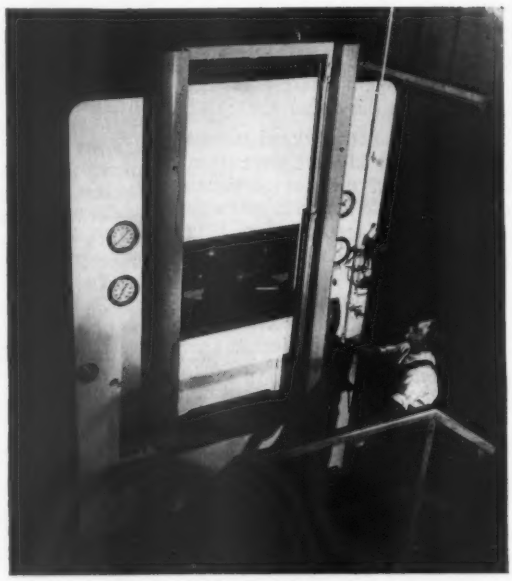
Sintered Friction Materials

Certain mixtures of metal or metal and ceramic powders, produce sinters which have outstanding properties as friction materials. A newly installed plant is designed to cater completely for current applications of the new materials

THE latest developments in friction materials are the metallic and cerametallic brake and clutch facings produced by sintering metal powder, or mixtures of ceramic and metal powders. The advantages secured are compactness, high duty, and low rates of wear: these features, singly or in various combinations, have significant influences upon the design and performance of certain machine elements.

An important step in the development of these materials in this country, particularly as concerns the control and transmission of power in road and rail vehicles, excavators, cranes, earth-moving machinery, tractors, and agricultural machines, is the decision of Ferodo Limited to extend the scope of their manufacturing activities to embrace the production of sintered metal and cerametallic friction materials.

The company has entered the field on an ambitious scale, providing sintered facings for new clutch and brake designs as well as a comprehensive range of replacement metallic facings. It has had the benefit, in the design of production plant, of the experience of the S. K. Wellman Company of America, who largely pioneered the application of sintered metals to the brake and clutch lining industry, and in collaboration with whom Ferodo Limited is already manufacturing these products on full-scale plant at the works at Chapel-en-le-Frith, Derbyshire.



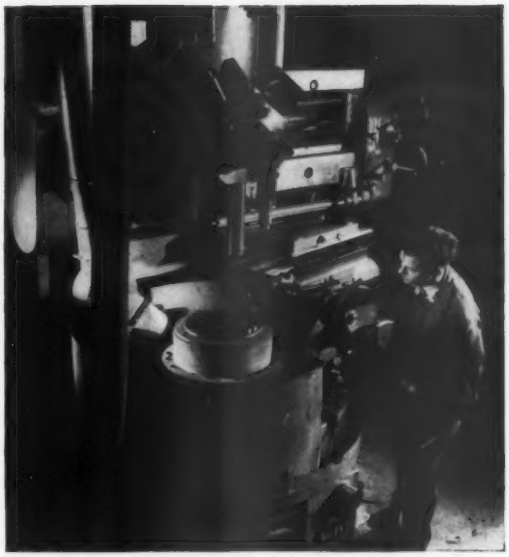
Hydraulic press for compacting metal powders

An operator removes an electric bell furnace after sintering to reveal the can containing the sintered parts

Until now, conventional friction materials, based on asbestos, have fulfilled all the demands made upon them. Ferodo sintered metals will not replace asbestos-based products, but they will make possible the design of clutches capable of sustaining duties beyond the scope of conventional linings and facings. They will also provide a Ferodo quality for replacement linings and facings on heavy equipment, mainly of American design, which have standardized metallic facings for certain brake and clutch applications.

Sintered metal linings are produced by the compression and partial fusion of very fine particles, mainly of powdered metals. Their physical properties, derived from their constituent metals, give them under certain conditions of high unit loading longer life and more stable friction than asbestos-based materials. They are naturally more expensive than conventional materials, but their use is justified by their performance under conditions which are beyond the range of conventional materials and where considerations of space make their use essential.

The facings are flat discs or segments generally built on to steel backing or core members, and may be very



Turning a set of sintered discs on a vertical boring machine

Fettling sintered metal friction linings

thin by traditional standards. The complete units may then be mounted by riveting; more frequently, the core member may be gear cut or splined to transmit torque. They are supplied for dry operation or in oil-immersed conditions, and give excellent service against normally accepted steel or alloy mating members, that is to say with a Brinell number of 160 or more in dry applications, although a lower Brinell number is acceptable for oil-immersed conditions. Cast steel is unsuitable for use as mating members since it is liable to be scored by whatever friction material is used.

Since dies and tools are an indispensable part of the manufacturing process, the maintenance of an economical price level is dependent on quantity production when special sizes are demanded; also, supplementary features like spline hardening, grooving and slotting increase the cost of the part.

Because metal powder material absorbs energy and conducts heat faster than most organic or mineral friction materials, it can be used under conditions which would lead to excessive temperatures for asbestos-based materials. Looked at another way, energy in the form of heat can be dissipated through the friction surface and the mating member, with the result that both surfaces run cooler and in consequence the life is increased. Less distortion and heat checking of the opposing member occur.

Though Ferodo sintered metals possess a lower coefficient of friction than conventional asbestos-based facings, that coefficient is maintained through a far wider range of temperature and pressure variations, a characteristic which gives smooth engagement and is particularly useful in protective and torque limiting clutches.

The metallic matrix is not affected appreciably by heat, cold or dampness, and quickly recovers from contamination by oil or solvents. On a dry clutch, the clutch action itself clears away foreign substances or fluids and, in doing so, restores the facing's coefficient of friction. Its structure being unaffected by oil, sintered metal is ideal for oil-immersed clutches, although naturally with a lower coefficient of friction than when operating dry.

Ferodo sintered metal friction materials can withstand higher normal pressures than asbestos-based materials without performance being affected. This property, together with the higher energy dissipation rates which can be catered for, makes possible the design of smaller, lighter and more compact clutches for high energy absorption applications.

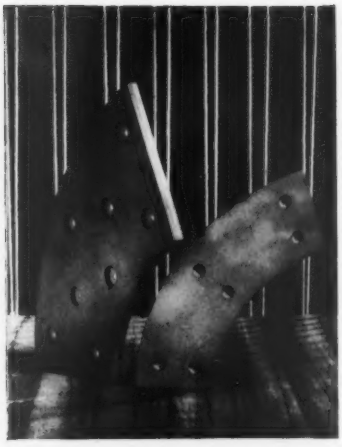
Ferodo sintered metal for dry applications is supplied with a special surface finish to ensure swift and smooth bedding in of the surface. This is not necessary for grooved facings operating in oil which are prepared with a normal machined finish.

In heavy-duty clutches and brakes sintered facings give consistent operation under arduous conditions. These applications include the steering clutches of crawler tractors, master clutches of all types of tractors, clutches for road rollers, steering clutches for tracklaying fighting vehicles (tanks, etc.) and for a multitude of other clutches and brakes in all types of earth-moving equipment.

Sintered facings are also useful in other clutches where consistent engagement characteristics are required. These include the multi-plate oil-immersed clutches employed in automatic gear boxes for all types of road and rail vehicles and also the clutches which lock up the torque convertors used in rail car propulsion. Torque limiting clutches and tensioning devices also fall into this category as do the host of small instrument clutches where smooth take up or break away is essential.

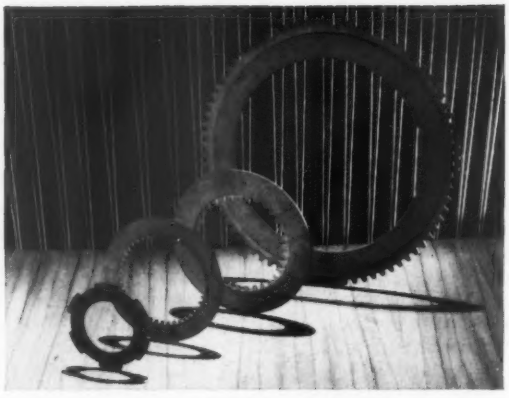
In most designs of electro-magnetic clutch and brake the air gap of the magnet is changed as the friction surface wears. Even the smallest change in the gap affects the clamping force considerably and therefore the wear of the friction facings must be kept to an

Fitting a Ferodo sintered metal brake disc to the hoist motor of a Le Tourneau Westinghouse D type Tournapull scraper



Ferodo sintered metal segmental facings formed on individual steel backing segments

Fitting an 18-inch clutch disc with Ferodo segmented sintered metal facings in a marine reverse gear assembly



One iron-based and three bronze-based Ferodo sintered metal gearcut facing discs

absolute minimum if excessively frequent adjustment is to be avoided. Sintered metal facings which can be prepared with only a very thin layer of very wear-resistant friction material enable the full use to be made of the available friction material whilst giving extremely good life between adjustments.

In compact clutches, where small size and weight is important, the ability of sintered metal to work at high pressures and energy ratings enables very appreciable reductions to be made to the size and weight of the clutch unit at the design stage. This is of particular importance for the many aircraft clutch applications, e.g. actuators, and has also an obvious advantage in such cases as racing-car clutches where weight is at a premium.

The basic processes involved in manufacture are as follow. The dry metal powders are accurately mixed and blended. They are then cold compacted at high pressures. The compacts are next assembled on their backings or cores which have already been prepared so as to assist the formation of a bond between plate and facings. The assembly, of compact and backing plate, is then sintered in a reducing atmosphere at temperatures up to 1000° C. After sintering, the assemblies are finished by grinding, edge trimming, drilling, branding and other necessary finishing operations. They are also finally inspected for dimensional accuracy before despatch.

Specifications

Ferodo SM1

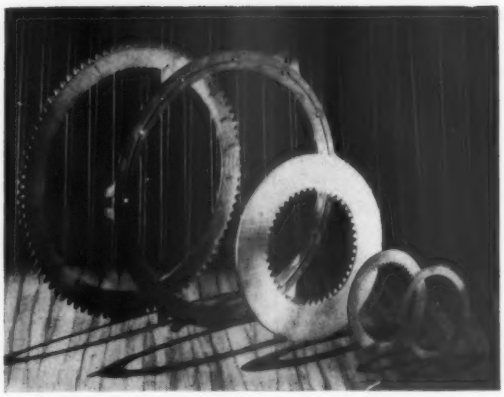
A general-purpose bronze-based sintered material for dry and oil applications where a reasonably high coefficient of friction is required and energy conditions are not unduly severe. Typical applications include master clutches, transmission clutches, steering clutches and various accessory clutches (e.g. power take-off clutches requiring a smooth and gradual take-up) used in earth moving, ordnance and industrial applications.

Ferodo SM2

This is a bronze-based sintered material which has been developed for oil-immersed applications requiring smooth, gradual engagement; for example, automotive automatic transmissions.

Ferodo SM3

This is a bronze-based sintered material which is especially suited to dry heavy-duty applications such as master or engine clutches on trucks and earth-moving equipment and on tractor steering and power control unit brakes. It contains several dry lubricants giving it excellent heat-resistant and anti-seizing properties.



Grooving on some Ferodo sintered metal gearcut facing discs serves to aid release and keep the face clear of wear particles in dry applications, and to disperse the oil film on engagement and distribute cooling oil in oil applications

Ferodo SM4

This is an iron-based sintered powder material with excellent heat-resisting qualities. It is used as a lining to protect costly parts, such as flywheels and pressure plates from heat damage and wear. Ferodo SM3 may be used to work against a SM4 mating surface. The friction values remain much the same as when SM3 is working against alloy cast-iron, but the combination offers some advantage in wear resistance under particularly heavy duty conditions.

Ferodo SM5

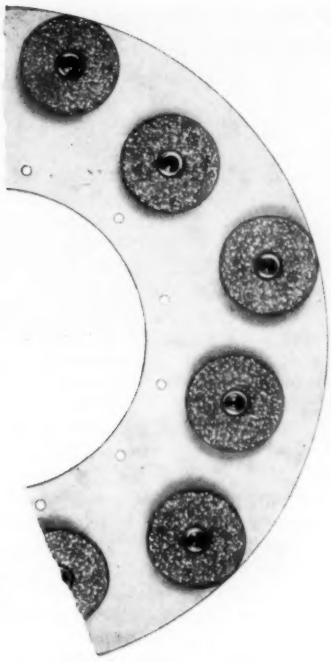
This is a bronze-based material designed for applications involving long slip periods. It provides for applications in seals, lubricated bearings and tension control clutches where consistency of friction level and low wear rate are the main requirements. It contains a relatively high percentage of lead which limits its operating temperature to about 500° F.

Ferodo SM6

This quality is again a bronze-based material intended for operation in oil. Its relatively high friction coefficient and flat torque curve make it suitable for applications where smooth engagement must be coupled with a relatively high capacity.

Backing plates

Ferodo Limited can supply sintered metal facings complete with cores or backing members or they can sinter the facings on to parts supplied by the customer. Cores or backing members can be produced from any steel which can be copper-plated. For some duties the use of a fairly high carbon type of spring steel is advantageous, especially where the core member is splined or gearcut to transmit the torque. The process



Ferodo cerametallic friction materials formed as circular pads in steel cups and riveted round a supporting member

used in applying Ferodo sintered metal to a core fully anneals the steel. Spline strength should therefore be calculated on the basis of the steel fully annealed.

The standard Ferodo cores or backing members are made from the following steels:

Backing plates or plain core plates	Mild steel (En2)
Core plates gear cut	En6, 0·3 to 0·4 carbon, i.e. equivalent to SAE1035 En42
Special gear-cut plates of automatic transmission type	En42
Special applications	En43F

Ferodo cerametallic friction materials are broadly similar to the sintered metal products already described, except that they contain a proportion of ceramic powder which increases their heat and wear resistance and raises their friction level. These advantages are to some extent offset by a tendency to abrasiveness and higher cost due to manipulating difficulties inherent in the material. The latter consideration makes it necessary to form the cerametallic friction material as a circular pad or button in a steel cup. A number of such buttons can then be riveted round the supporting member. The principal applications for cerametallic materials are the clutches of earth-moving machinery, agricultural machinery and disc brake pads for aircraft.

PHYSICAL PROPERTIES OF FERODO SINTERED METAL LININGS

	SM1	SM2	SM3	SM4	SM5	SM6
Friction value for design purposes (dry)	0.24	—	0.26	—	0.23	—
Friction value for design purposes (oil)	0.05	0.04	—	—	—	0.07
Static friction value (dry)	0.35—0.38	—	0.34—0.36	—	0.26—0.28	—
Static friction value (oil)	0.10—0.12	0.12—0.14	—	—	—	0.10—0.12
Dynamic friction Value (dry)	0.29—0.32	—	0.30—0.33	—	0.2 —0.21	—
Dynamic friction value (oil)	0.06—0.08	0.05—0.07	—	—	—	0.9 —0.99
Ultimate tensile strength (psi)	6,700	10,200	6,500	12,500	7,500	6,500
Ultimate shear strength (psi)	8,500	11,400	9,300	13,400	10,400	9,000
Cross breaking strength (psi)	17,500	21,000	19,100	16,300	18,200	18,500
Density (lb/cu in.)	0.216	0.2341	0.216	0.202	0.227	0.214

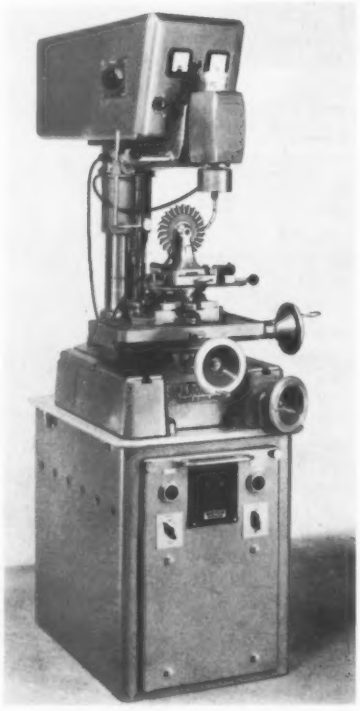
Spark Deposition of Tungsten Carbide on Tool Steels

During the early stages of development and research of using the spark-machining technique Impregnated Diamond Products Limited, Tuffley Crescent, Gloucester, makers of the Sparkatron machine encountered a problem of the transfer of electrode material from the tool to the work-piece which occurred under certain electrical conditions. In solving the problem the possiblity arose of exaggerating the conditions which produced the phenomenon and employing them as a method of imparting a very hard surface layer to tool tips and other surfaces subject to heavy wear. This reverse process can now be accomplished with their Sparcard machine which employs a system of electrical parameters very similar to those of the Sparkatron, the major difference being in place of the substitution of a vibrator for the servo-head used in spark machining equipment.

The cabinet base of the machine houses the transformer and power supply equipment, the condensers and the output side of the circuit are accommodated in the head which is also provided with voltmeter, ammeter and the switches controlling the spark discharge. The vibrator situated immediately below the head, is provided with a clamp to hold the tungsten carbide electrode, and a micrometer depth control for fine adjustment of the electrode while working. Coarse control is by hand wheel.

Surfacing a milling cutter held in the worktable of the Sparcard and using a tungsten carbide electrode

The main worktable is provided with T-slots and carries a compound table of conventional design with V-slides giving longitudinal movement of 12 in. and transverse of 6¼ in. both operated by hand wheel. A universal tool holder for single point tools, reamers and milling tools is provided which will take cutters of up to 8 in. dia.



Sparcard machine for tungsten deposition on tool steels

The work head which is locked by a clamp to the column during operation is arranged to swing clear during setting up of the work.

The workpiece should be ground and thoroughly degreased prior to mounting in the tool holder. The method of operation is to bring the electrode in contact with the work and with the current switched on traverse the electrode across the electrode surface to be treated. A rheostat is used to regulate the spark discharge using the ammeter and voltmeter to maintain a constant condition. Four discharge settings of condenser power are provided to treat tools for heavy, medium or fine finish use. Since there is an air gap between electrode and workpiece an intense blue spark is created in the gap and operators are advised to use the dark glasses provided in order to reduce eye strain.

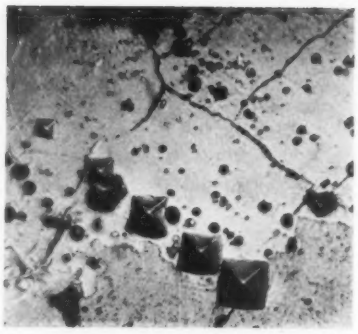


Fig. 1. Hardness test on a workpiece shows a marked change in the diamond indentation after spark treatment. Vertical magnification ×4000, horizontal ×700

The treated surface closely resembles that which has been machined by the spark machining technique in that it is composed of a multitude of shallow craters. Micro photographs reveal that the craters are lined with hard metal and that the hardening effect penetrates deep into the sub surface zone. Fig. 1 shows very clearly the remarkable increase in hardness created by the process as demonstrated by the diamond indentation pattern.

Treatment is usually confined to the top rake of high speed steel tools where chip erosion is most marked. However, when front rake wear is heavy it may be advisable to treat this area. Minor irregularities in tool surface are automatically compensated by adjusting the amplitude of vibrator oscillation.

Dial Indicator for Lathe Work

Made for saddle attachment so that it engages with the lead screw the Ceewrite indicator enables any number of lengths and depths over the whole working length of the lead screw to be obtained to within limits of ·001 in. It eliminates the use of depth micrometers, slip gauges, standard or vernier micrometers and the time lost in stopping the machine for checking purposes.

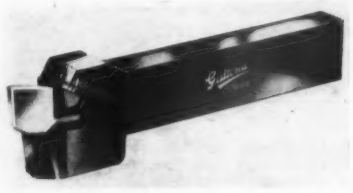
Operation is very simple. The lathe tool is applied to the work piece and a facing cut taken if required. The indicator dials are then set at zero, allowing any tool movement in a longitudinal direction to be read directly from the dials. The dials can then be reset

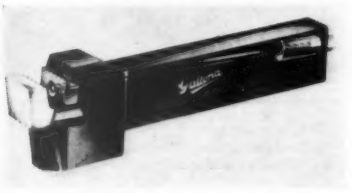
Ceewrite dial indicator

at zero if required. The indicator is manufactured in eight models, with either fractional or decimal dials, and various settings, and is marketed by Alfred Herbert Limited, Coventry.

Serrated Bit Tool Holders for Planers and Shapers

Popular in the U.S.A. for many years Galtona-OK serrated bit tool holders are now being made in the U.K. by Richard Lloyd Limited, Galton House, Elmfield Avenue, Tyburn, Birmingham 24 These tool holders and bits are intended for the larger lathes, shaping and planing machines, and boring mills. Initially a range of 19 shapes of tool bit in the "E" series is being produced in both high speed steel and carbide tipped. Tool holders may be front lock or rear lock style, in various shapes including drop-head as illustrated, straight base type or gooseneck. The tool bits are serrated on their base, and are positively held in place by the inclined back stop which bears the full thrust of the cut. The high leverage lock and system of mating serrations serve only to hold the tool bit in place, the clamp being practically free from all strain. The serrations permit sideways adjustment to allow for regrinding.





Galtona tool holders for planers and shapers have two styles of locking, left, front lock and right, rear lock for confined conditions

Disc-filing machine for Dressing Soft Materials

A new machine which will assist in speeding up production in a very wide range of industries is being marketed by Stanley Works (G.B.) Limited, Rutland Road, Sheffield 3. Using a non-clogging cutting disc the Stanley Discut machine is powered by an electric motor which drives the cutting disc, through a gearbox, at a speed of 400 rpm. The thin steel disc, measuring 10 in. dia is supported on a backing plate, the

Stanley Discut machine

spokes of which help to draw air through the teeth and thus keep the disc cool.

Its main uses are for filing, shaping or fettling aluminium, lead, copper or brass castings or other materials which are not readily cut by grinding wheels.

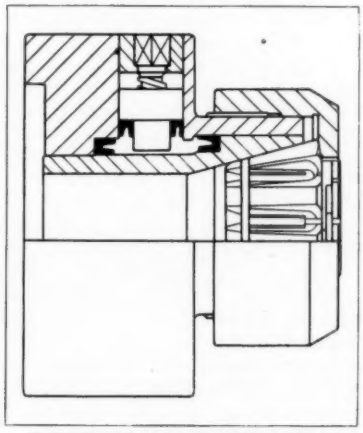
The discut readily cuts all kinds of plastics and can be used for such operations as trimming mouldings or forming stock.

AIR GAUGING BENCH INDICATOR.—The range of air gauging equipment being manufactured by Teddington Industrial Equipment Limited, Sunbury-on-Thames, now includes a new portable bench stand known as Type 81. This unit with a 5 in. scale is available for magnifications from 1250 up to 12,500 and is suitable for use with any of the Teddington gauging fixtures. The standard model includes a built-in air filter, air-supply hose with quick-release couplings and air-supply pressure gauge

Hydraulic Chuck Reduces Collet Requirements

After five years of extensive trials and testing the Crawford hydraulic chuck, originally patented in 1953 is now available for use with Multi-bore collets in two sizes 1 in. and 2 in. capacity. Its main advantage is the reduction in the number of individual collets needed to cover diameters from ¼ to 2 in; it is stated that each collet has sufficient range to replace ten ordinary collets, concentricity being maintained over the whole range. The extra long bearing surfaces of the collet jaws remain parallel and in full contact with the workpiece throughout its range.

A feature of the chuck made by Crawford Collets Limited, Witney, Oxon., is the self-contained hydraulic system which provides ample power for closing the collets.



Section through the Crawford hydraulic chuck

Hinkley Point

World's first 500,000 kW atomic power station

The accompanying sectional view shows one of the two reactor buildings for the world's first 500 MW atomic power station at Hinkley Point, Somerset, now being constructed by the English Electric—Babcock & Wilcox—Taylor Woodrow Atomic Power Group for the United Kingdom Central Electricity Generating Board, in association with which this station was also designed by the group.

There are two, gas-cooled, graphite-moderated reactors each contained in a 67 ft dia. spherical pressure vessel of 3 in. thick steel. The weight of each reactor with pressure vessel is 5,500 tons. The fuel is natural uranium in magnesium alloy cans. Refuelling is from the top of the reactor while the reactor is under pressure and on full power.

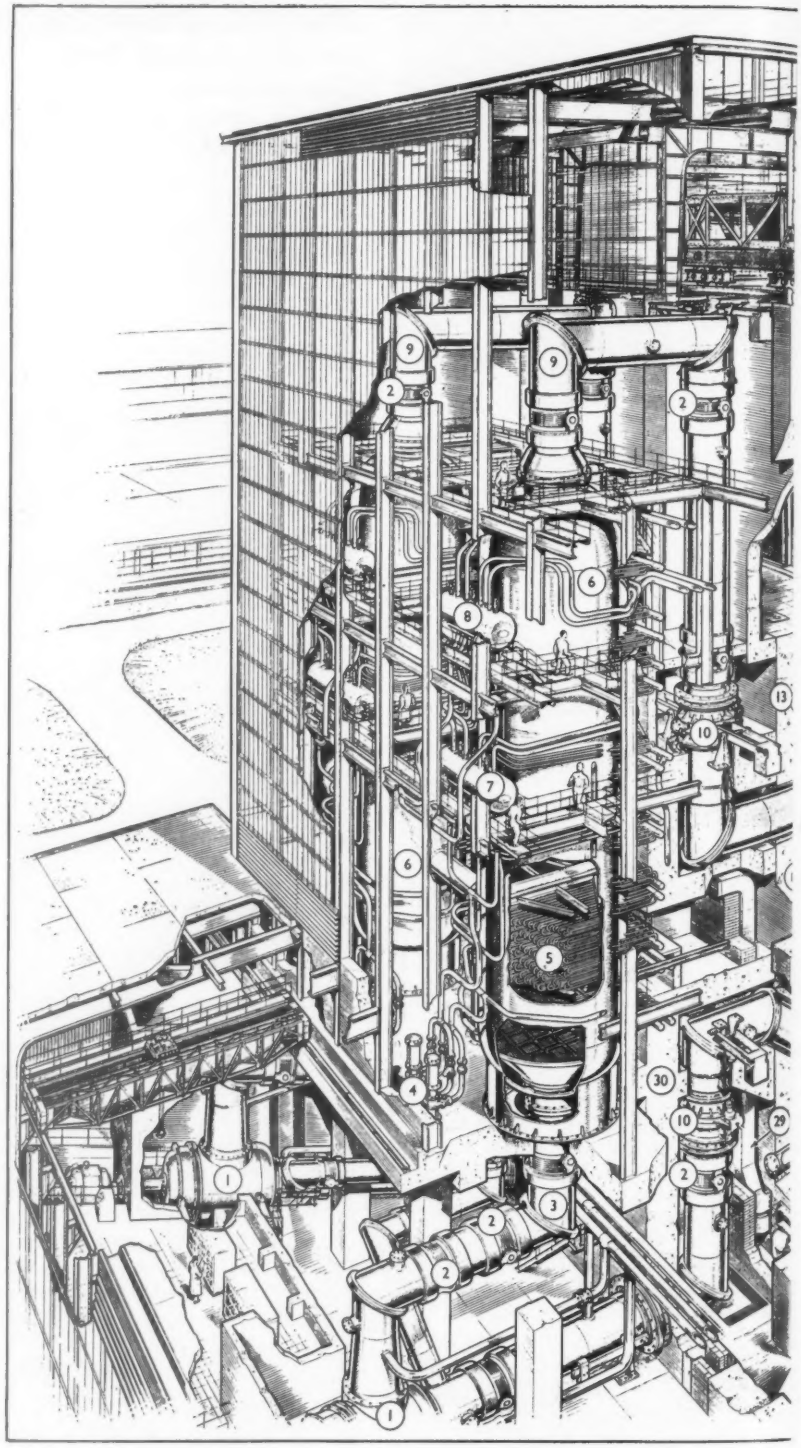
There are six boilers per reactor, of the Babcock dual-pressure type, each 90 ft high, 21 ft 6 in. dia. and weighing 1350 tons. The total evaporation is 5·5 million pounds of steam per hour. There are six gas circulators per reactor, electrically-driven and of the axial-flow type.

Main electrical generation is by six 3000 rpm English Electric, hydrogen-cooled, 3-cylinder turbo-alternators, each having 93·5 MW capacity at 13·8 kV, 0·85 power factor. For auxiliary generation there are three 33 MW variable-speed turbo-alternators for supplying the gas circulators and other duties.

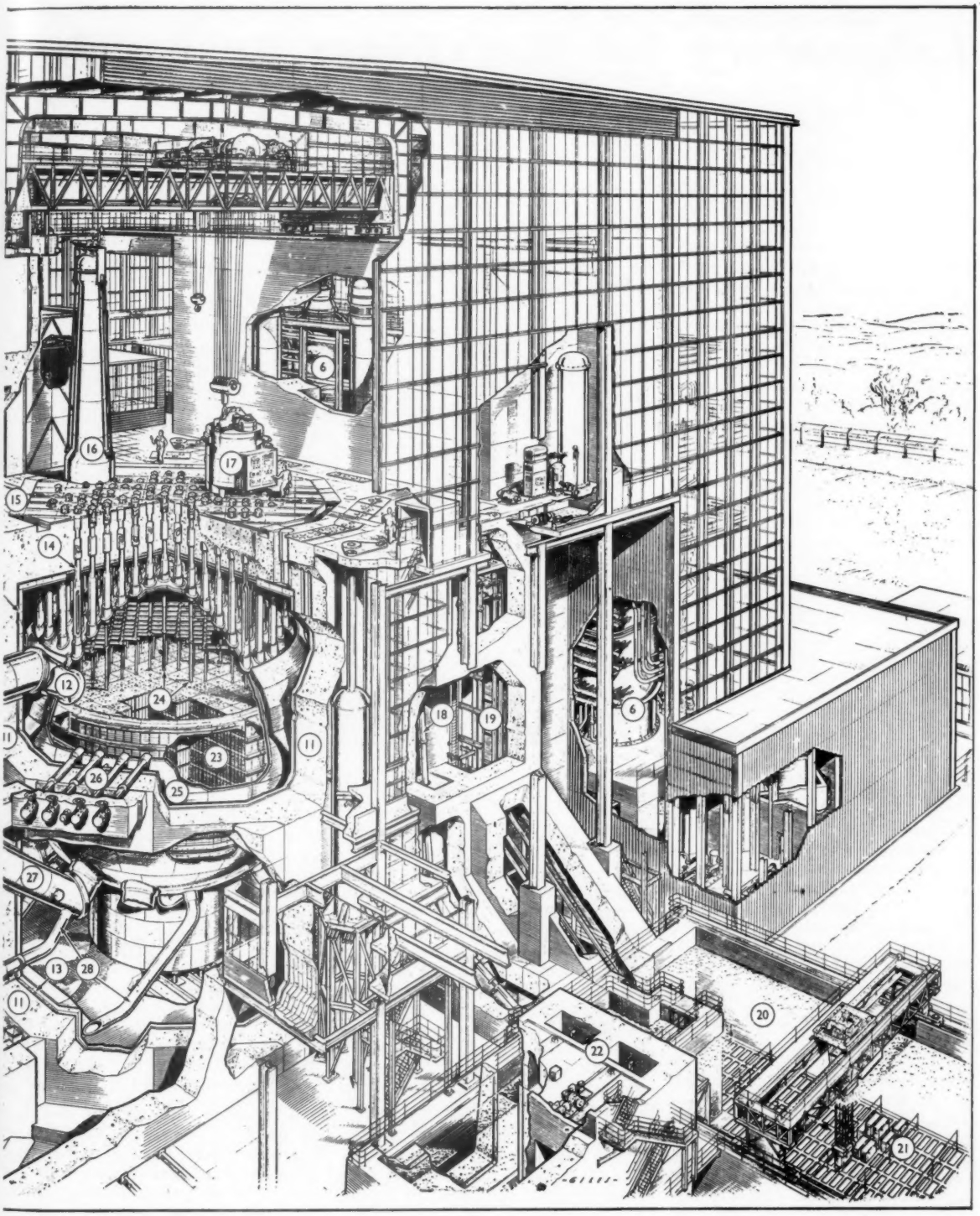
Transmission is via a switching and transformer station into national supergrid system at 275 kV.

For cooling purposes 35 million gallons of sea-water will be circulated per hour by six centrifugal pumps.

The civil engineering work includes the construction of two 180 ft high reactor buildings, the 740 ft-long turbine-hall and all other buildings, reactor biological shields of high-density concrete, 7 ft thick, 3000 ft-long sea-wall, circulating-water intake with 2200 ft-long tunnels under the sea-beds: dock, wharf, approach roads, etc., altogether involving 750,000 cu yd of excavation and the placing of 300,000 cu yd of concrete.



1 Coolant-gas circulating blowers.
2 Hinged expansion bellows.
3 Coolant-gas outlet from steam-raising unit.
4 Steam-raising unit circulating pumps.
5 Stud-tube elements.
6 Steam-raising units (six per reactor).
7 Low-pressure steam drum.
8 High-pressure steam drum.
9 Coolant-gas inlet to steam-raising unit.
10 Coolant-gas isolating valves.
11 Main biological shield.
12 Coolant-gas outlet from reactor.



13 Thermal shield.
14 Charge tubes.
15 Charge floor.
16 Hole-preparation machine.
17 Charge and discharge machine.
18 Emergency discharge chute.
19 Spent fuel-element skip hoist.
20 Cooling pond.
21 Storage skips and grid.
22 Skip loading bays.
23 Graphite-moderator core.
24 Control rod.
25 Reactor pressure-vessel.
26 Can-failure detection standpipes.
27 Coolant-gas inlet to reactor.
28 Debris-removal ducts.
29 Shield cooling-air dusting.
30 Secondary biological shield.

Laboratory for Beryllium Research

The use of beryllium as a fuel-can material in nuclear reactors offers the possibility of raising operating temperatures to 600°C., but unfortunately its toxic nature introduces machining and fabrication hazards. The safety measures adopted at the G.E.C. Atomic Energy Division laboratory are discussed here

THE possibility of using beryllium as a material for fuel cans used in gas cooled reactors is now being actively pursued in a new laboratory established by the General Electric Company Limited at the headquarters of their Atomic Energy Division, Erith, Kent. Beryllium has a very low neutron-absorption cross-section; its melting point (1280°C) is considerably higher than that of other metals already used for this duty; its resistance to oxidation is good both in wet and in dry carbon dioxide; and its high-temperature strength is excellent.

The ability to use this metal at very high temperatures is particularly significant. Current information suggests that a beryllium fuel-can could probably be operated at temperatures of about 600°C which would permit the maximum gas outlet temperatures from the reactor to be raised by at least 100°C above the level possible in current designs. Such an increase would result in a considerably higher thermal efficiency for a nuclear power station.

Methods of eliminating the hazards arising from the metal's toxicity have been thoroughly investigated both in this country and in the U.S.A., and, as a result, a number of recommendations have been made. The principal feature in the standards adopted by the U.K.A.E.A., and applied in the design of the new laboratory is the necessity of obtaining a working atmosphere where the average atmospheric concentration of beryllium does not exceed 2 millionths of a gramme per cubic metre throughout the working day. In order to achieve this standard, considerable care must be devoted to each operation involving beryllium and special techniques may be required in particular cases. For example, dusty operations such as grinding require more precautions and protective installation than some other, non-abrasive, operations.

Working boxes for experiments on oxidation and heat treatment of beryllium at the G.E.C. beryllium research laboratory

The laboratory is a two-storey brick building with a concrete roof. For all normal purposes, the only means of entry is through a change room which is divided into two parts. On the entry side of a barrier, all personal clothing is left in lockers, while on the contact side complete laboratory clothing, including head- and foot-gear, is provided. In addition, there are washing facilities and a shower. A washing machine complete with spin drier, and a drying cabinet are installed, as no laundry is sent out from the laboratory.

The laboratory itself is divided into two areas, A and B. The A area is designed for operations of greater potential hazard, and has a higher air-extraction rate than B. Double emergency doors open out of the building from laboratory area B and these, though normally sealed, are also used where necessary for the introduction of plant and machinery. The first floor houses the service room and the extract-filter room, and also provides some office and laboratory accommodation for the Medical Radiobiology Department.

Liquid effluent is discharged to a 400 gal inspection and holding tank, which can be monitored. This tank acts as a water seal on the laboratory drains, so that air cannot be drawn into the building via the drainage system. A small filter is installed at each of the points where there is a danger of finely divided beryllium being discharged into the drain.

Since much experimental work is to be carried out in a pressurized CO_2 atmosphere, a supply of this gas is piped round the laboratory at a pressure of 150 psi. A normal supply of compressed air is available but, in addition, a separate compressor is installed to provide a low-pressure, clean air supply for air masks and pressurized suits. All laboratory services can be isolated from the

service room, without having to enter the laboratory itself.

Ventilation system

The laboratory areas are completely air-conditioned by means of one central inlet air duct, and two ranges of extract ducting which run along the laboratory walls at ceiling height. A fan having a capacity of 6000 cfm draws air into the building through a bank of filters followed by a steam-to-air heat-exchanger thermostatically controlled to maintain an inlet air temperature of 75°F.

The extract system consists basically of a fan drawing air at the rate of 8000 cfm from the laboratory through 12 Vokes Absolute filters which are arranged in two banks of six, coupled in parallel to the extract fan. Each filter has a guaranteed efficiency of 99·95% removal of particles in the range 0·1 to 0·5 micron in diameter. For particle sizes greater than 1·0 micron, the efficiency of removal is virtually 100%. The state of each filter is shown by a manometer.

The extract air is drawn from the laboratory through working boxes and hoods, which are coupled to the main extract ducts. The maximum linear air velocity in the main extract is 1000 fpm. The quantity of air extracted from the laboratory is greater than that admitted through the inlet manifolds thus by creating a slight negative pressure in the laboratory, air leakage can only occur into the building. The extract filter system has been designed so that a filter can be changed with the ventilation plant running.

A duplicate set of fan motors and starters is installed. The motors are arranged for two-speed operation so that the ventilation plant can run at approximately half-speed during non-working periods in the laboratory. Mechanically and electrically interlocked starter switches make it impossible to start the inlet fan until the extract fan is running, and failure of the extract-fan motor automatically switches off the inlet fan. Failure of the extract system initiates a visual and audible alarm.

Initially, all experimental procedures involving the handling of beryllium will be carried out in ventilated working-boxes, each designed around a specific operation. All welding or machining operations involving the formation of beryllium dust or chip are confined to laboratory A, where the highest ventilation rate is available. The boxes are of two types; for experimental work at elevated temperatures, they are constructed from sheet metal, on an angle-iron frame; for general laboratory techniques, such as metallography, a perspex hood is attached to a conventional bench. Access to the interior of the hood is gained through a perspex working face with a single hinged door, opening outwards, and a series of sliding doors. The hinged door provides a single maximum opening in the box, which can be subdivided by means of the sliding doors. For welding work, a glove-box is used; access to this box is gained by means of arm-length rubber gloves sealed to the working face. This arrangement is, in fact, the familiar dry-box, modified to accommodate a high air velocity.

Operating procedure

In spite of the elaborate precautions taken in the design of the installation, it is essential, if all risks of beryllium poisoning are to be completely avoided, for each laboratory operation to be proved safe before it is allowed to be conducted on a routine basis. Each new operation is initially performed in fully protective clothing with an external air line. Using this procedure, the operation in question can be carried out while air samples are taken at a number of points in the immediate vicinity of the operator. These samples provide a means of ascertaining that the operation can be conducted safely, that is without exceeding, or indeed approaching, the maximum permissible level for atmospheric beryllium concentration. Once this has been established, the work can be continued without an air line or the associated protective clothing.

Beryllium monitoring is difficult, and, at present, the use of spectrochemical techniques on a bath-sampling basis provides the best safeguard. In collaboration with the G.E.C. Research Laboratories at Wembley, a sampling and analytical scheme has been established using air samples of about 10 cubic metres. By the methods employed, as little as 0·015 millionths of a gramme of beryllium can be detected.

In addition to air monitoring on specific operations, routine background samples are taken daily in the laboratory over a period of 8 hr.

Batteries for Dounreay

Three large stationary batteries manufactured by Pritchett & Gold and E.P.S. Company Limited of Dagenham Dock, Essex, have recently been supplied to the United Kingdom Atomic Energy Authority for the new Atomic Power Station at Dounreay, Scotland. Two of these batteries will supply essential emergency services in the main station, the other is for switchgear operation and indication in the Dounreay switching station. Complex charging and control equipment has also been supplied for the batteries in the main station.

Largest of the three is a 240 volt battery, which, among other duties, powers essential control equipment in the event of a failure in the mains supply. A reliable source of emergency supply is imperative since any failure would result in considerable damage to the reactors. The battery is made up of 120 open top glass cells with a capacity of 800 Ah at the 10-hr rate. There are two independent charging and control equipments, each supplied under normal conditions by separate incoming mains power lines. Only one set of equipment is energized at a time and an a.c. change-over contactor is mounted on the control cubicles. The duties of this battery include the provision of supplies to d.c. auxiliaries, pumps, emergency lighting, control rods for the reactors and two motor alternator sets, only one of which would be supplied during an emergency. The total load is nearly 400 amperes, which the battery will maintain for one hour. Under normal conditions, this load is provided from the incoming twin a.c. mains supplies, by two rectifiers, across which the battery floats.

The second battery in the main power station is a 50-volt installation of 25 closed-top cells with a capacity of 75 Ah at the 10-hr rate. Charging and distribution equipment has again been supplied by Pritchett & Gold. The duties of this battery include emergency supplies to a variety of indicating, alarm, control, metering and recording instruments.

For the Dounreay switching station, the company have supplied, through A. Reyrolle & Co. Limited, a 110-volt battery consisting of 55 closed-top cells with a capacity of 150 Ah at the 10-hr rate.

Research Facilities for Gas-cooled Reactors

Research and development facilities of the G.E.C. Atomic Energy Division at Erith, Kent, have recently been considerably expanded. New laboratories have been established, and a large quantity of new equipment has been installed in those already existing. Their provision will enable detailed experimental investigation to be made for improving the original design of gas-cooled, graphite-moderated reactor, increasing efficiency and reducing costs, and adapting it to meet special requirements, particularly for the overseas market.

Reactor model for gas-flow measurements

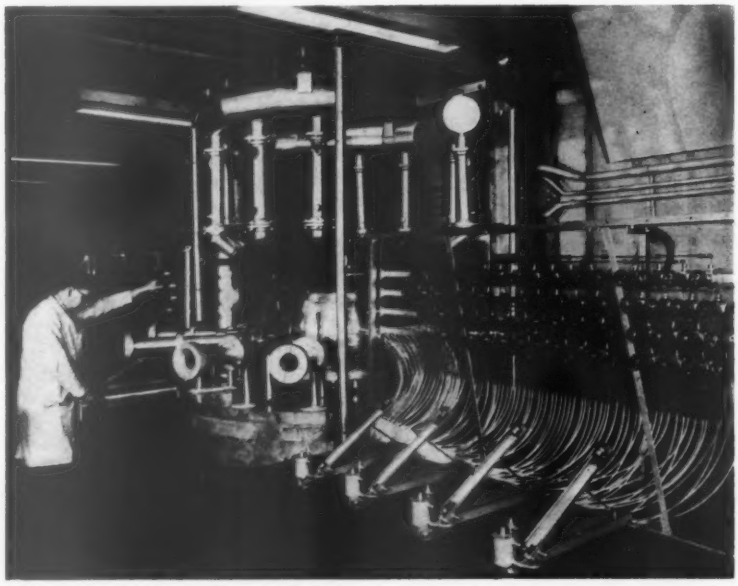
One of the most impressive pieces of apparatus in the Mechanical Engineering laboratory is a 1/20-scale model of a power reactor of the type being built at Hunterston. This model is used to carry out investigations concerning the flow of coolant gas within the reactor. Housed in a 42 in. dia perspex sphere, a scale replica of the reactor pressure vessel complete with its supporting skirt and its ring of inlet and outlet ports, is a model of the reactor core. This core, which is made of duralumin, rests on a support-grid of the same "egg-box" type as is employed in the actual reactor. The vertical fuel and control-rod channels through the core are represented by tubes of a number and diameter such that the core as a whole offers proportionally the same resistance to gas flow as will the full-scale structure.

A motor-driven blower, coupled to the outlet ports in the perspex sphere, draws air through the model to simulate the flow of coolant gas in the reactor. Measurements are made of the flow of air at the inlet and outlet ports and of the pressure drop along selected channels through the core. By these means it is possible to investigate the symmetry of the gas-flow through the reactor and to study the effect of shut-down of one or more of the eight gas-circuits which connect the reactor vessel to the steam-raising units. The influence of "gags" to restrict the flow of gas through the channels can also be determined.

Fuel-element insertion tests

When a fuel element is inserted into the reactor core during a charging operation, it is subjected to a considerable and relatively abrupt rise in temperature. A test rig has been built to ensure that this "thermal shock" has no deleterious effect on the structure of the fuel element.

The rig comprises a horizontal cylindrical channel, 14 ft long and 6 in. bore filled with carbon dioxide at a pressure of 150 psi. A length of this channel is heated at one end by means of two 5 kW electrical heating elements supported on refractory-cement sleeves, so that by varying separately the supplies to the two heaters, the temperature-gradient over the heated length can be varied.



Reactor model for gas-flow measurements at the G.E.C. Mechanical Engineering laboratory

The complete fuel element under test is mounted on a carriage which can be moved along the channel, into the heated zone, by means of a chain driven by a handwheel. With this arrrangement, the effects of different rates of insertion can be studied for various values of the temperature-gradient to which the element is subjected.

Transient-temperature tests on reactor-support skirts

The spherical pressure vessel of the present G.E.C. design of power reactor is supported by means of a cylindrical skirt welded to the vessel. It is desirable to study the effects on this skirt of sudden changes in the temperature of the coolant gas in order to prove conclusively that no excessive stresses are set up, particularly in the vicinity of the skirt-to-shell weld.

For this purpose, a 1/3-scale model of a section of pressure vessel and skirt has been constructed. The model is mounted in a sheet-steel enclosure encased in firebrick, and a motor-driven blower circulates carbon dioxide over its surface to simulate the gas flow in the reactor. The gas is heated by means of a 20 kW electric heater, the input to which can be controlled to give the required variations in gas temperature. The gas velocities and temperatures employed in the model have been calculated so that they will produce effects equivalent to those that will be experienced in the full-scale structure. The temperatures at various points on the model are measured by means of thermocouples and are recorded on a 16-way recorder.

Uranium-to-can heat transfer

The maximum uranium temperature in a power reactor is fixed partially by the temperature drop between the uranium and the metal can in which it is enclosed. Two test-rigs are being used in the laboratory to measure the heat-transfer characteristics involved.

In one of these, which is used for basic research work, discs of uranium and of the canning material are arranged face-to-face. One face is then heated and thermocouples are used to determine the temperature distribution along the heat path through the discs. By this method, the effect of using different canning materials, different surface finishes, and different gases to fill the small residual spaces in the can, may be determined.

The second apparatus used for tests on complete fuel elements is made in tubular form and an electric heater is inserted in the bore. The complete element is enclosed in a pressure vessel containing Dowtherm, a fluid which boils at about 450° C with a vapour pressure of 150 psi. These are the temperature and pressure conditions that will exist within the reactor, and the use of Dowtherm therefore eliminates the need for a comparatively complex system for supplying pressurized gas to the apparatus. Continuous refluxing of the Dowtherm is obtained by providing a small condenser in the top of the pressure vessel. Thermocouples are provided to measure the temperatures at various points in the uranium and in the fuel-can.

Bearing and shaft-seal tests

Rigs for the testing of bearings and shaft seals under reactor-operating conditions have been designed to investigate the performance of different types of bearing when running in pressurized carbon dioxide at various temperatures. In each unit, two bearings are mounted on a shaft which runs inside a cylinder containing carbon dioxide, under pressure and electrically heated. The bearing housings are fastened to the cylinder walls, so that the frictional torque tends to drag the cylinder round with the shaft. This is prevented by means of an adjustable counter-balance weight, the position of which gives a measure of the frictional torque. Weights attached to the cylinder serve to load the bearings whilst temperatures are continuously recorded by means of thermocouples and chart recorders, and the frictional torque, bearing wear, and shaft wear, are measured at frequent intervals.

Among the types of bearing that have been investigated are those employing graphite, in a number of forms and mixtures, and various kinds of plastics. The effects of different shaft finishes have also been examined.

Two types of shaft seal have also been extensively investigated, the Flexibox seal, and a viscous seal using oil as the sealing medium. Active development work on both these types is being carried out on test rigs in the laboratory.

Welding bay

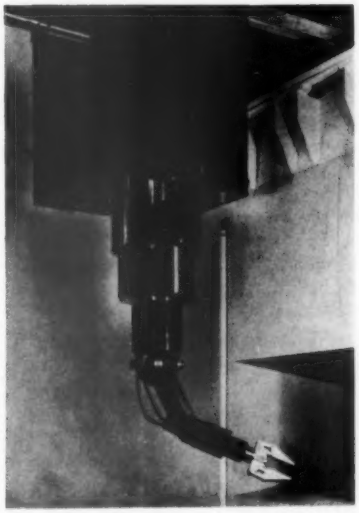
The quality of the large amount of welding involved in a nuclear power station is receiving considerable attention from the welding group at Erith. The welding bay in the new laboratory is equipped to perform any type of hand-welding operation and also experiments with a number of semi-automatic processes. The work of the group falls roughly into three fields—research and development on welding processes in general, specific problems arising from reactor design, and general welding as a laboratory service.

Remote Handling by Power Manipulator

The first general-purpose power-operated manipulator to be designed and produced in Europe, has been developed to provide remote-handling facilities in any situation where it is impossible, or undesirable, to employ a human operator. While the basic design was produced in the General Electric Company's Atomic Energy Division at Erith, Kent, mainly with a view to its use in the nuclear-energy field where toxic and radio-active materials must frequently be handled, it is equally applicable, for example, in certain chemical plants where poisonous atmospheres or hazardous processes are involved. The machine is extremely versatile, it can lift and accurately position objects weighing as much as 750 lb, handle delicate glassware without breakage, pour and stir liquids, and wield a large variety of hand and power-operated tools.

The complete operation of the manipulator is controlled by one person from a small console which is readily movable and can be conveniently positioned according to the viewing arrangements. Unlike the hand-operated manipulators commonly used for light handling duties, there is no mechanical linkage between the machine and the console, the only connexions consisting of multicore electric cable. There is, therefore, no limitation on the distance between the power manipulator and the operator as long as some means of remote viewing, such as closed-circuit television, is available.

In designing a manipulator of this type it was of paramount importance to attain complete reliability and ease of maintenance, thus ensuring the longest possible periods between overhauls which might be complicated by the need for decontamination of the machine. Again, compactness of design was desirable in order that the headroom required, and the dimensions of doors necessary for the



Left, G.E.C. power manipulator for remote handling radio-active material up to 750 lb in weight. Right, operating console has two hand-operated joysticks for controlling the motions and switches for locking in position

passage of the machine from one working area to another could be kept to a minimum. These features represent considerable economic advantages due to the high costs involved in the construction of heavily shielded cells. Furthermore, a compact, clean-lined machine is easier to cover with protective bagging and to decontaminate.

Finally, the manipulator may have to work in proximity to large sources of gamma radiation. Special attention has therefore been paid to the design of all non-metallic parts such as electrical insulators, lubricants, and paints, which may deteriorate under such conditions. As far as possible the use of organic insulating materials has been avoided.

Mechanical construction

The manipulator consists of a grasping device carried on a wrist, capable of continuous rotation, which is supported from a forearm, upper arm and shoulder. The arm joints are designed so that each section can rotate through 180° about its pivot, while the shoulder joint can rotate continuously about a vertical axis.

The shoulder is mounted in the base of a set of vertical telescopic tubes, the upper section of which is rigidly fixed to a crane-type carriage. This carriage can be traversed across a gantry spanning the working area and travelling on longitudinal rails mounted near the top of the walls of the cell. The gantry also supports a 1½ ton electric hoist, with a cross-traverse parallel to that of the manipulator carriage for normal lifting duties and for supporting equipment on which the manipulator is working.

The telescopic tubes, which are housed in the carriage when in their stowed position, have a positive raise and lower action, the sliding movement between tubes being taken on anti-friction bearings running on stainless steel paths. The driving motor for the tubes is mounted in the carriage. The lowest tube houses three drive units, one for shoulder rotation, one for the shoulder pivot by which the upper arm is moved, and one for the elbow pivot which controls the movement of the lower arm. The drives to the two pivots are transmitted through sets of gears mounted in the shoulder casting, followed, in the case of the elbow pivot, by a train of spur gears inside the upper arm. A 20-way slipring column, through which the electrical connexions to the rotating section of the manipulator are made, is also housed in the lowest telescopic tube.

Mounted on the lower arm are two drive units, one for the wrist which gives continuous rotation in either direction, and the other for the grasping device of which two are normally supplied. The more versatile of these takes the form of a hand with two jaws capable of a maximum opening of 5 in. and of applying a gripping force of any value up to 150 lb. The jaws are opened and closed by means of a parallelogram linkage driven by a rack which, in turn, is coupled to the drive unit by a differential gear. The torque on the arm of this gear is used to provide an indication of the pressure applied by the jaws, a spring deflected by movement of the arm being arranged to actuate a transducer.

The alternative device, which is mainly used for lifting duties, comprises a hook which can be driven against an anvil, the same drive unit being used for both the hook and the hand.

The grasping devices can be interchanged remotely. The device already attached to the manipulator is driven into a fixture which grips it firmly and, at the same time, releases a locking ring on the wrist. The wrist is then rotated until the device frees itself. The other device, which is housed in another fixture, can then be attached to the manipulator by carrying out the reverse process.

The basic elements of the manipulator can be assembled in a variety of ways to fit different sizes of cell, and can be arranged for other forms of mounting than that of suspension from a crab moving in a horizontal plane.

Electrical Drives and control equipment

As the operator can at all times see the manipulator, either directly or through some remote-viewing device, he is given control of the speeds of movement of the various components rather than direct control of their actual positions.

All the motions which can be varied in speed over a range of 8 to 1 are powered by variable-frequency, 3-phase, squirrel-cage induction motors. This type of machine was selected on account of its rugged construction, compact size, freedom from brushgear, and the fact that no insulating material is required in the small rotors. The stator windings are of wire insulated with silicone and glass, and the slots are lined with mica. The solid insulation is made of silicone-bonded glass laminates.

The small motors used for powering the arms of the manipulator are fitted with integral electromagnetic brakes which operate from the motor flux. The brake linings are of phenolic-bonded asbestos which was chosen for its resistance to gamma-radiation damage. The larger motors for the long-travel, cross-traverse, and telescopic-tube drives are provided with separate shoe brakes with silicone and glass insulated coils. All of these brakes are essentially for holding purposes to ensure that there is no movement in the event of a power failure. Limit-switches are provided at both ends of the travel of each component to prevent any damage to the machine due to overrunning.

The structure of the 20-way slip-ring column in the lower telescopic tube is fabricated entirely from Micalex using silver-graphite brushes rubbing on silver sliprings, two brushes being used per ring to form the connexions.

The wiring of the manipulator is carried out in a specially selected P.V.C. cable which will still remain flexible up to quite high gamma-radiation dosages. The connexion between the head and the base of the telescopic tubes consists of a self-coiling multicore cable which is normally stored in a cylinder at the base of the tubes. The electrical supply to the manipulator is also by a P.V.C. multicore cable resting on sheaves mounted at intervals along the side of the gantry track. A weighted take-up pulley is employed as a means of storing the cable.

The variable-frequency supply for the manipulator driving motors is obtained from small motor-alternator sets which are housed, together with their associated control gear, in a separate floor-mounted cubicle. The alternators, which have a fixed excitation, are driven by variable-speed d.c. motors. Speed variation is obtained by means of magnetic-amplifier control in the armature circuits, the resulting outputs ranging from 14 to 110 V and from 12·5 to 100 c/s. The control windings of the magnetic amplifiers are fed from potentiometers which are coupled to two joysticks mounted in the front face of the control console.

All the movements of the manipulator are controlled by means of these two joysticks. The joystick handles have simultaneous freedom of motion in four directions, each direction being associated with a corresponding movement of one of the manipulator components. The degree of displacement of the joystick is proportional to the speed of the corresponding manipulator movement. The motions of the joysticks are arranged to follow logically those of the manipulator so that a relatively unpractised operator can control the machine with ease.

The control for the hand or hook has been designed so as to permit adjustment of both the closing speed and the grip force. These two features are incorporated in one joystick motion so that low grip-force is associated with low speed, since a high speed of closing on to a delicate object is not a natural requirement.

The outward thrust or gripping force between the hand jaws is indicated on an instrument mounted on top of the console. This instrument is non-linearly scaled 0 to 150 lb so that the 15 lb graduation is in the midscale position, thus ensuring adequate sensitivity of indication when handling light or fragile objects. A further indication of grip-force is provided in the form of an audible signal from a variable-frequency oscillator so that the operator can, when necessary, concentrate on watching the manipulator.

Switches for controlling the hoist block and for locking any of the manipulator motions in a given position are provided on the top of the console.

Measures for the Safe Operation of Reactors

The measures being taken by the United Kingdom Atomic Energy Authority to ensure that the Calder Hall and the future reactors of the Central Electricity Generating Board can at all times be operated in a safe manner were described by Sir John Cockcroft in the James Forrest Lecture given before the Institution of Civil Engineers. The following is an extract from the lecture.

The Windscale accident has focussed attention on the storage of energy in graphite. As the graphite in reactors is bombarded by fast neutrons, carbon atoms are knocked out of their normal places in the graphite lattice and take up interstitial positions. If these atoms return to vacant lattice positions the stored potential energy is released. The rate at which energy is accumulated depends markedly on the temperature at which irradiation occurs. The higher the temperature the less the rate of accumulation of stored energy since some self annealing occurs.

The stored energy can be released by raising the temperature of the graphite above its normal operating temperature. The energy then is released rather slowly over a period of a day or so as the thermal wave spreads. If this occurs with the coolant flowing the temperature rise will be small. If, however, it occurs under adiabatic conditions with no coolant flow and the energy stored exceeds the specific heat, the temperature will rise.

The lowest graphite temperature of the Central Electricity Generating Board reactors will be about 20° higher than Calder Hall so that the time before an anneal will be required should be very much longer and might approach the 20-year assumed life of the reactor.

Another important safety problem is the transient behaviour of the reactor under fault conditions such as the failure of electricity supply to the CO_2 circulators. We have to be sure that under fault conditions the temperature rise of the fuel element is small and cannot possibly rise to the melting point of the magnox alloy, which is about 650°C. Initially the Calder type reactors have a negative temperature coefficient of reactivity. This means that as the temperature of the fuel element increases, the surplus of neutrons decreases, the reactivity falls, and this tends automatically to reduce the temperature increase. As the chain reaction proceeds however U.235 is destroyed by fission and partially replaced by plutonium which has different nuclear properties. The result of this is to change the transient characteristics of the reactor. The designer has to ensure that the control system of the reactor and the characteristics of the blower take account of these changes.

Another important safety problem is the integrity of the pressure drum. During fabrication, welds are individually radiographed and the whole drum is stress relieved. We have, however, to guard against changes in the ductility of the steel due to neutron bombardment. The brittle fracture transition curve of steel is known to be shifted to higher temperatures by neutron bombardment and we have to be careful that the transition temperature does not rise above the operating temperature. So Lloyds Register have steel specimens inside the pressure drum and they are withdrawn at intervals and tested to see how the properties are changing. Accelerated tests are also proceeding in DIDO.

Another important safety requirement is that of containment of any radioactive products which could be released by fault conditions. The Calder type reactors provide by their closed circuit a first line of defence against this. The leakage of CO_2 has been reduced to 2% per day so that any out-leakage would be slow.

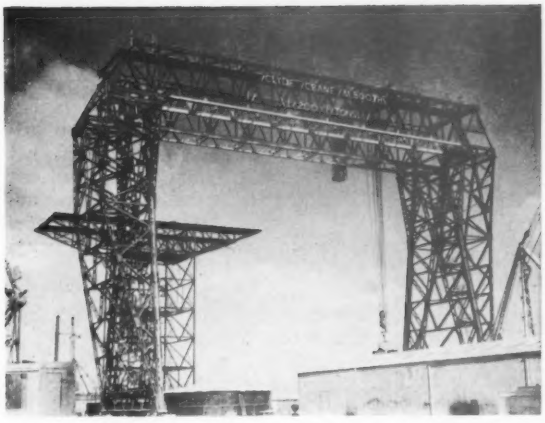
It is necessary also to ensure that any blow down circuits are properly protected by filters which could be sure of taking out a large proportion of any particulate fission products.

It is worth noting that if the permeability of the Windscale filters had been ten times less we would have had no public health anxiety after the accident due to emission of radio iodine and consequent contamination of milk—and this in spite of a major fire in which about three tons of uranium was oxidised. The lessons learnt from the Windscale accident will help to ensure the safety of nuclear power development in the future.

Bradwell Goliath

The Goliath crane which has been erected on the site of the nuclear power station at Bradwell-on-Sea, will be used to lift the very heavy boiler and reactor structures. In each of the two reactor buildings there will be six boilers, 19 ft dia and 87 ft high, and a spherical steel pressure vessel of 67 ft dia to contain the graphite core and uranium charge. The boiler shells, each weighing nearly 200 tons, will be floated down the North Sea to Bradwell from the works of Head, Wrighton & Co. Limited, Thornaby-on-Tees. The reactor pressure vessel is of such a size and weight (1100 tons) that it will have to be fabricated on the site.

The crane, which has been constructed by Clyde Crane and Booth Limited, Rodley, Leeds, an associate



A general view of the Goliath crane and a view along one of the girders showing the horizontal bracing

company of Clarke, Chapman & Co. Limited, Gateshead, is designed to lift a maximum load of 200 tons dead weight suspended vertically from the main hook. An auxiliary hook to carry a 30 ton load is also provided. The two hoists hang from a normal type crab mounted on a pair of twin girders, each provided with its own horizontal outrigger girder to give lateral stiffness and providing vertical clearance of 140 ft. The girders are mounted on a pair of legs of similar construction, the main vertical loads being taken through pin joints in order to get correct load transfer. The rear end of one leg is anchored to its corresponding girder, the rear end of the other leg being left free to float. In effect, this is a pendulum leg which can be made rigid as required. The base end of each leg is pin-jointed to equalizer beams which, in turn, transmit the load to the bogies.

The crane contains many large fabrications: they were welded with Flexend electrodes supplied by Rockweld Limited.

The hoisting equipment consists of standard crane spur hoist gearing housed in totally enclosed steel gear boxes, the shafts running on ball and roller bearings. The barrels are of steel tube construction machine grooved and arranged to coil the rope without overlapping. Overwinding and overlowering switches are provided for each hoist.

The load from each leg is transmitted through a main equalizing beam which spreads the load to two other equalizers which, in turn, are connected to the bogies. The attachment to the bogies is through a universal connexion which gives equal distribution of load over all the axles in any one leg. Bogies and equalizer beams are of fabricated steel construction, the wheels and axles are of the rolled steel railway pattern running in phosphor bronze bushed bearings. Half the total number of axles, i.e. four axles in each leg, are driven through worm and spur gearing with coupling rods for transmitting the drive from the geared axle to its mating axle in the same bogies. An indicator synchronized by Selsyn control is provided so that the driver in the crane cabin can see to what extent bogies are being maintained in line, and provision is made for driving one end of the crane separately in the event of it being necessary to re-align the crane. The bogies run on standard gauges railway lines; the length of track is 1200 ft. There are eight 20 hp travelling motors and the speed along the track with a 200 ton load is 50 ft per min.

Clarke, Chapman & Co. Limited is a member company of The Nuclear Power Plant Company Limited, the contractors for the Bradwell station. The sub-contractor for the steelwork of the Goliath crane was the Tees Side Bridge & Engineering Works Limited, Middlesbrough.

Automatic solenoid brakes are fitted to each hoist, and in addition the speed of lowering is controlled electrically. Two solenoid brakes are fitted to the transverse motion to hold the crab in position when the current is off, and normal braking is obtained by plugging through the controllers. Eight solenoid brakes are fitted to the travelling motion to hold the crane when at rest, normal braking being again obtained by plugging through the control gear; in addition, storm clamps are provided to give further safety anchorage for the crane in gale conditions.

The crane is operated from a cage which travels with the crab. Each motion is capable of independent operation by means of a master reversing controller which operates magnetic contactor gear. The speed of lowering on each hoist is governed by potentiometer dynamic braking and the rating of the resistances is such that the full load can be lowered the full length of travel of the hook once per hour. Suitable protection is provided against overcurrent and low voltage.

The Goliath Crane is supported at each end by a leg mounted on eight four-wheel bogies. Flexend welding electrodes produced by Rockweld Limited, were used in the construction of these bogies

Fusion Welded Pipe

Accurate control with television viewing

AT the Coatbridge works of Stewarts and Lloyds Limited, equipment which has recently been installed for the manufacture of electric fusion welded pipe comprises a continuous edge forming and seam welding machine for external welding and an internal welding boom for backing up welds. In comparison with a conventional fusion welded pipe mill, fewer operators are required to operate the equipment and the amount of time taken to change from one pipe size to another is reduced. Tacking of pipes before welding is not necessary and the use of multipower Unionmelt gives welding speeds which are twice those provided with single wire welding.

The Quasi-Arc/Torrance continuous edge former and seam welder forms the edges of the pipe and welds seams in one operation. It handles pipe from 18 in. to 50 in. outside diameter in plate thicknesses up to $\frac{5}{8}$ in. The pipe lengths are fed through the machine continuously, butted end to end, by a succession of drive rolls, power driven at an infinitely variable welding speed by a $7\frac{1}{2}$ hp motor to give a range of welding speeds between 30 and 96 in. per min.

As the pipe lengths, which have already been rolled into shape, enter the machine, the edges pass between two edge forming rolls mounted one above the other. These rolls break the plate edges to produce a circular pipe with good fit-up between the faces of the joint to be welded. Five sets of edge forming and drive rolls are required for the complete range of pipe sizes.

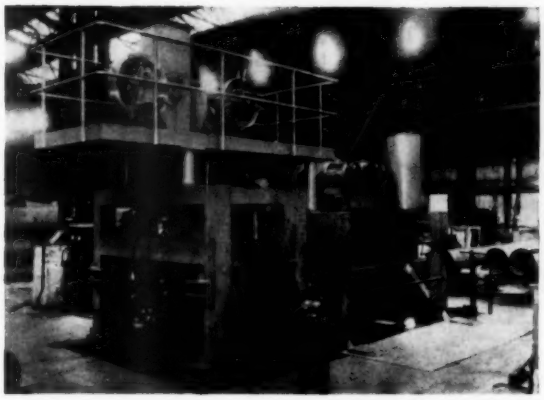
The machine has two Unionmelt D.S.H. welding heads, the lead head powered by a continuously rated 1200 ampere d.c. rectifier power unit, and the trailing head by a 1000 ampere a.c. transformer power unit, continously rated at 800 amperes.

A copper backing shoe is positioned on the underside of the joint underneath the welding heads, being mounted at the end of a cantilever arm suspended from the entry point of the seam welder. A circulating water system is used to cool the copper shoe. With the shoe in position, a completely penetrating weld can be made with the machine. The machine is equipped with a continuous circulating system for welding powder.

The internal welding equipment comprises a Unionmelt D.S.H. welding head with feed roll and nozzle assembly for parallel electrode welding, mounted at the end of a boom 30 ft long. The boom remains stationary while the pipe is moved at welding speeds on a traversing roller bed.

The main part of the boom is substantially rigid, but the end is supported by small rollers bearing on the bottom of the pipe. A closed circuit television system is used to enable the operator to see the line of joint ahead of the welding nozzle so that he can make any necessary adjustments.

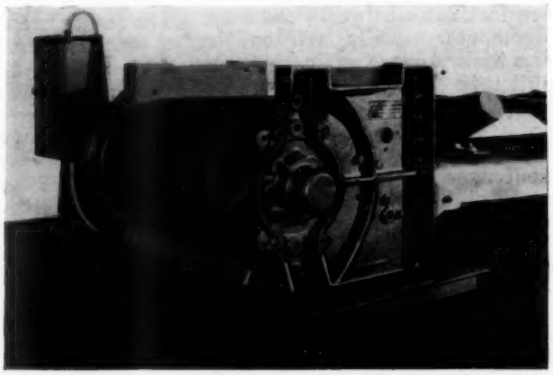
Welding powder is carried in a hopper mounted at the end of the boom, whence it is fed by gravity to the weld zone. Unfused powder is picked up, a short distance behind the welding nozzle, by a vacuum suction unit mounted at the base of the boom with a hose extending through the centre of the circular boom.



This continuous edge forming and seam welding machine feeds pipe continuously with minimum interruption of the welding procedure

An additional feature is provided by the forming rolls which break the plate edges as the pipe sections enter the machine. Considerable capital expenditure and labour costs are eliminated by the use of this method, since these rolls make it unnecessary to provide other machines (with their operators) for breaking the plate edges prior to rolling or press forming.

The equipment is designed not only for speed and economy, but also for high-quality welding. Close control of all welding variables is a necessity for this purpose, and the use of closed-circuit television on the welding boom marks advance over previous methods of visual control, such as observation of the "hot-spot". Accurate control of the welding head during internal welding of pipes with inside diameters as small as $17\frac{1}{2}$ in. is made possible by this equipment.



CONVEYOR DRIVING GEAR.—This size 25 small driving unit for belt conveyors has been designed by Mavor & Coulson Limited, Bridgeton, Glasgow S.E. to take 6 hp from the motor when the belt speed is 270 fpm. Silent V-ropes absorb the shock of any sudden heavy load, and the second speed reduction runs in oil. The drives are self-contained and weatherproof and suitable for field conveyors as well as in permanent sites

Vibration Control. By John N. Macduff and John R. Curreri. New York, 1958; McGraw-Hill Book Company Inc. London; McGraw-Hill Publishing Company Limited. 70/- net (by post 71/9). 465 pp. 6 × 9 in.

Most of the books for engineers written about vibration are concerned with avoiding vibration and its effects. This is not the only engineering interest, but it is the one commanding the widest interest and the title of this book is probably the best way of describing it. The book is for both students and engineers and therefore teaches both the principles and the practice of the subject. The first half deals with principles—response of simple systems, differential equations and single degree of freedom systems, steady-state response of lumped parameter systems, natural frequencies of simple systems, steady-state vibration isolation, and mechanical transients; and the remaining chapters with applications—balancing, lateral vibration of shafts, torsional vibrations, sound and noise control, and automatic control systems. The extensive bibliography will be of particular use to the practising engineer requiring references to published treatments of specific problems.

Electronics in the Office. London, 1957; Office Management Association. 21/- net (by post 22/-). 132 pp. 7¼ × 9½ in.

A few firms use computors as part of their business organization: many more could do the same, but the computor is very new and strange. However, people who use cars and television sets without ever hoping or intending to understand or even look into the works could use a computor equally well on the same basis. Anyone approaching the subject in this way will find this book useful. It contains the proceedings of a conference held by the Office Management Association and is in four parts. The first shows how an organization described to its staff in a non-technical way the means of input, storage and output of a typical computor; the second describes how three firms from widely different industries carried out investigations before deciding whether or not computing equipment could be justified economically for their clerical work; in the third is described the practical experience of four organizations in the use of electronic data processing equipment for clerical work; and the fifth describes equipment which was the subject of diagrams and literature displayed at the conference.

The book is therefore a compendium of practical experience and serves admirably as an introduction for the prospective user.

books

Hydraulics and Fluid Mechanics. By E. H. Lewitt. London, 1958; Sir Isaac Pitman & Sons Limited. 37/6 net (by post 39/3). 732 pp. 5½ × 8½ in.

This well-known text book in the publishers' "Engineering Degree Series" now appears in a 10th edition, with new type and rearranged and enlarged to cover the revised examination syllabus in fluid mechanics. Both liquids and gases are dealt with and there are chapters on hydraulic machinery, meters, pumps and turbines. Supersonic speed now has a chapter to itself, and there is a new chapter on the frictional flow of gases through tapering pipes, and another dealing with the frictional flow of gases through ducts of any cross-section. The symbols in this new edition conform generally to the recommendations of the British Standards Institution.

Off-peak Electric Space Heating.—A series of articles by Leslie Shepherd on this subject which appeared in "The Industrial Heating Engineer" have been reprinted in booklet form and issued by John D. Troup Limited, 90 High Holborn, London WC1, price 6/- post free. The author, who is heating engineer to the Eastern Electricity Board, deals with the economics of the subject and discusses hot water thermal storage systems, block type thermal storage heaters, electrically warmed floors, and explains the estimation of heating requirements.

The incentive to use the method arises out of the off-peak tariffs introduced in recent years. It will obviously become rapidly more important as nuclear energy generation expands because of the relatively constant output from such stations.

Fuel Economy.—This year's edition of the "Fuel Economy Review" published by the Federation of British Industries, 21 Tothill Street, London SW1, price 5/-, opens with a survey of the nuclear energy programme by Lord Citrine who predicts that a progressive lowering of nuclear generation cost to below that of steam plant can confidently be expected. Other articles in the Review deal with the utilization of fuels at an integrated steelworks, heat recovery plants for paper machines, electric furnace economies, the instrumentation and automatic control of shell boilers, the calculation and use of Degree Days, fuel efficiency in the wool textile industry, some modern developments in boiler feed water treatment, and simple smoke indicators.

Current British Directories.—There are so many directories that it is a great convenience to have a comprehensive list of them from which to select those suitable for any particular purpose. Such a list has been compiled and edited by Mr. G. P. Henderson, Commercial Reference Librarian at the Guildhall Library, London. It is published by Jones & Evans' Bookshop Limited, 70 Queen Victoria Street, London EC4, price 30/- (by post 31/-). It lists the local, trade and professional directories of the British Isles and an appendix gives a selection of international specialised directories published abroad.

Job Evaluation.—A group of three articles entitled "What's it Worth ?" has been issued in pamphlet form by The Institute of Industrial Supervisors, 24 Albert Street, Birmingham 4, price 1/-. In the first article Mr. W. M. Jones of Imperial Chemical Industries Limited discusses job appraisement, in the second an anonymous contributor from the General Electric Company Limited deals with job evaluation in a large engineering works and gives a table of points awarded for various factors relating to staff and manual occupations, and in the third Mr. W. H. Lovell of Guest, Keen & Nettlefolds (Midlands) Limited sets out a case history in job evaluation.

A.E.S.D. Pamphlets.—Two new pamphlets have been added to the technical series published by The Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey. One of them, entitled "The Fundamentals of Jig Design", was originally written 30 years ago by D. Watson and has now been

brought up-to-date in a new issue by W. H. Storey. It is very concise and informative and gives much detail on design procedure. The second pamphlet is "Grading of Metallic Starting Resistors for Electric Motors—with Examples", and is by E. W. Brass. It explains the electrical calculations involved in providing the graded electrical resistances required in starting-up a motor, and covers the starters for shunt, series and compound d.c. motors, d.c. slipring and a.c. squirrel cage motors.

Methods of Testing Thermocouples and Thermocouple Materials.—Circular 590 issued by the U.S. National Bureau of Standards (U.S. Government Printing Office, Washington 25, D.C., U.S.A., price 32 cents by post) by Wm. R. Roeser and S. T. Lonberger, describes methods of testing thermocouples and thermocouple materials, and mainly considers calibration of platinum versus platinum-rhodium, copper-constantan, Chromel-Alumel, and iron-constantan thermocouples, and some guidance is provided in the selection of a test method best adapted to a given set of conditions. One section discusses calibration at freezing points, melting points, and boiling points, while another covers calibration by comparison methods. The accuracies obtained in calibrating the various types of thermocouples by different methods, and the uncertainty in the interpolated values by various methods are presented in a table.

Trigonometry and Calculus Refreshers for Technical Men.—The two American books bearing these titles which were reviewed in our issue of April last year are now being issued in the U.K. by Constable & Co. Limited. The English price is 16/- net for each volume.

A.S.M.E. Publications.—The 20-page 1958 list of the publications of the American Society of Mechanical Engineers gives particulars of periodicals, books, safety and test codes, American standards and pamphlets. It is issued from the society's office at 29 West 39th Street, New York 18, N.Y., U.S.A.

New Standards

Z.A.D.C. Standards for Pressure Die Castings.

Many buyers of die castings tend to demand finer tolerances than many applications require, in the mistaken belief that the finest attainable tolerances can be achieved easily in the course of normal production. To bring home to users and potential users of die castings that it is generally unnecessary to specify very fine tolerances for all dimensions in any one casting and that fine tolerances need usually be held only on a few dimensions, the Zinc Alloy Die Casters Association have issued standards similar to those adopted in the U.S.A. for use in the U.K. The standards, covering zinc and light alloys, were prepared by their technical committee in collaboration with the American Die Casting Institute and with the assistance and approval of the technical committee of the Light Metal Founders Association. Copies are available on request from the Zinc Alloy Die Casters Association, 34 Berkeley Square, London W1.

Power-driven travelling jib cranes (Rail-mounted low carriage type) (B.S. 357:1958). Price 10/-.

The purpose of this revised publication is to indicate minimum constructional requirements and to ensure reliability and safety in use. It places no restrictions on the general design of cranes or on the methods employed in their construction. The standard deals with travelling jib cranes (power-driven, rail-wheel-mounted, on low carriage) of the following types: non-shunting, free on rail; shunting, free on rail; portable type; any of these types using outriggers and any with part slewing.

Detailed requirements are specified for the design of the crane structure and hoisting equipment, brakes, electric motors, controllers and protective gear. The clause on stability has been modified and there is now only one set of co-efficients. Test requirements are tabulated for easy reference.

The appendices include a full list of standards for materials and equipment suitable for use in manufacture, information regarding load capacity of gears, and definitions of crane speeds.

Intrinsically safe electrical apparatus and circuits (B.S. 1259:1958). Price 4/-.

The principal feature of this revision of B.S. 1259:1945 is the introduction of a list of flammable gases and vapours in respect of which apparatus may be accepted for test and possible subsequent certification. These gases and vapours are placed in four classes methane, pentane, ethylene, hydrogen for the purposes of tests which are described in an appendix.

The standard specifies general requirements for all types of electrical equipments which may be regarded as being safe for use in dangerous explosive atmospheres by virtue of their electrical design and circuit characteristics—as opposed to equipment in a flameproof enclosure (B.S. 229). The term "intrinsically safe", as applied to electric circuits and apparatus, is defined; and requirements relating to the certification of equipment so described.

B.S.I. Adopts International Paper Sizes.

The B.S.I. announced that as from March, 1958 the sizes of paper it uses for all purposes will be taken from what is known as the international "A series", which have already been adopted by 26 foreign countries and are likely to be formally adopted as a world standard.

Their main advantage is that every size in the series has precisely the same proportions, a relationship which greatly simplifies the sizing of illustrations for reproduction especially when photo-enlargement and reduction processes are involved. The basic dimensions are ·841 mm wide × 1·189 mm high (i.e. 1 sq m in area), smaller sizes being obtained by halving the longer dimension and larger sizes by doubling the shorter one.

A full schedule of the A series is given below, which shows that the standard dimensions are the millimetre ones, the inch equivalents being given only to the nearest $\frac{1}{8}$ in.

THE A SERIES OF PAPER SIZES

Designation	Size in millimetres	Equivalent in inches (to nearest $\frac{1}{8}$ in.)
4A0	1682 × 2378	66⅛ × 93⅝
2A0	1189 × 1682	46⅞ × 66⅛
A0	841 × 1189	33⅛ × 46⅞
A1	594 × 841	23⅜ × 33⅛
A2	420 × 596	16½ × 23⅜
A3	297 × 420	11⅝ × 16½
A4	210 × 297	8¼ × 11⅝
A5	148 × 210	5⅞ × 8¼
A6	105 × 148	4⅛ × 5⅞
A7	74 × 105	2⅞ × 4⅛
A8	52 × 74	2 × 2⅞
A9	37 × 52	1⅜ × 2
A10	26 × 37	1 × 1⅜

British Standards Institution, 2 Park Street, London W1.

BUSINESS & PROFESSIONAL

Personal

BABCOCK & WILCOX LIMITED announce the appointment of **Mr. Hector McNeil, B.E., M.I.Mech.E., M.I.E.E., F.Inst.F.,** as managing director of the company. He succeeds **Sir Kenneth Hague, M.I.Mech.E., M.I.E.E.,** who expressed the wish to relinquish that position, which he had held since January 1945. Sir Kenneth will continue to devote his services fully to the company in his position as deputy chairman. **Mr. J. Stewart Robertson,** general manager, has been appointed a director to fill the vacancy created by the retirement from the board of directors, at his own request, of **Mr. C. H. Sparks,** who has been a director for the past 18 years. Mr. Sparks will continue as engineering consultant to the company.

Mr. T. Herd, for the last 12 years manager of the Birmingham office of Brook Motors Limited, has now been transferred to London to take over as general manager of the London sales office.

GEORGE KERR LIMITED of Luton, Beds. are to establish a central organisation in Australia under the direction of **Mr. E. E. Cook, M.Inst.F.,** whose position as home sales manager is being taken over by **Mr. J. Tham. Mr. K. Scanes,** previously exhibitions manager, has taken over from Mr. Tham the responsibility for relations with overseas subsidiary companies. **Mr. W. G. Askew,** publicity manager, has assumed responsibility for the exhibitions department.

Mr. T. P. Rome, D.F.H., A.M.I.E.E., has been appointed Liverpool branch manager of British Insulated Callender's Cables Limited, in succession to **Mr. L. J. Fairhurst,** retired.

Mr. D. A. C. Bennett, Dunlop's overseas sales manager, has been appointed to the local board at Fort Dunlop, Birmingham.

BALDWIN INSTRUMENT COMPANY LIMITED, Brooklands Works, Dartford, Kent, announce the appointment of **Mr. John D. Thornley** as northern England representative of the fluid power division. Prior to joining Baldwins he was commercial manager of James Holt (Engineers) Limited. Mr. Thornley will be operating from the following address: Waterhey Cottage, Rivington, nr. Bolton, Lancs. Telephone Horwich 364.

Mr. R. M. W. Lowe, recently of the engineering department at Appleby-Frodingham Steel Company, has been appointed manager of United Steel new London drawing office. responsible to **Lt.-Commander G. W. Wells,** managing director (engineering works) of United Steel and director and general manager of Appleby-Frodingham Steel Company.

Mr. Arthur Booth, formerly general manager of Cyclemaster Limited, has been appointed director and general manager of Landmaster Limited, Hucknall, Nottingham, a member of the Firth Cleveland Group.

METROPOLITAN - VICKERS ELECTRICAL Company Limited, announces that **Mr. N. R. D. Gurney, A.C.G.I., M.I.E.E.,** is appointed sales manager, plant department. Formerly chief engineer, electrical general engineering department, Mr. Gurney succeeds **Mr. R. J. Cochran,** who is seconded to special duties.

THE following new appointments to the board of Oldham & Son (Africa) Limited are announced. **Mr. Clive Corder** (chairman of the Syfrets Investment Trust) has been appointed deputy chairman, in succession to the late **Mr. A. J. T. Goldby. Mr. A. M. Rosholt,** C.A., a partner of Goldby Panchaud and Webber, chartered accountants, has been appointed as financial director. **Mr. G. A. Curry,** chairman and managing director of J. H. Vivian & Company Limited, has been appointed to the board as a director.

Mr. R. J. Masterson, Expandite Limited, (Overseas Division), manufacturers of sealing compounds and jointing materials, has taken up appointment as manager, Central African Division. His address in the Federation will be c/o P.O. Box 394, Salisbury, Rhodesia. **Mr. P. L. Critchell,** technical advisory officer to Expandite Limited has been appointed manager of the newly formed sales development department.

CAMBRIDGE INSTRUMENT COMPANY LIMITED, announce that **Mr. L. F. Cooke,** previously head of the industrial sales department, has been appointed commercial sales manager. **Mr. A. T. Jones** has been appointed sales manager of the mechanical thermometer division at Finchley. **Mr. S. A. Bergen, M.B.E., M.I.E.E.,** has been appointed chief development engineer of the Cambridge organization.

Obituary

WE regret to record the death of **Mr. Henry Herbert Clayton,** home service manager of F. Perkins Limited, and also manager of the company's engine rebuild department. Mr. Clayton, who was 61, joined the Peterborough diesel engine company in 1944 as supply manager.

WE regret to report the death of **Mr. C. K. Bird,** who until he relinquished the position for health reasons at the end of March 1956, was manager of turbine contracts, The British Thomson-Houston Company Limited, Rugby. From that date he was consultant to the manager Turbine Contracts. He was in his sixty-sixth year.

WE regret to record the death, after a prolonged illness, of **Mr. Norman W. Taylor,** director of Charles Taylor (Birmingham) Limited, at the age of 64. Mr. Taylor had been with the firm all his working life, for many years in the position of works manager. He was appointed director in 1946.

WE regret to record the death of **Sir James Swinburne, F.R.S.,** until 1948 chairman of Bakelite Limited. He had only recently celebrated his hundredth birthday. Sir James, who until his death was honorary president of the company, was a distinguished engineer and one of the world's pioneers in the field of synthetic resins. His original work on phenolic resins at the beginning of the century made a major contribution to the development of the British plastics industry, of which it can be said he was the founder. He was a past president of the Institution of Electrical Engineers, and a past president of the Faraday Society, and a member of the Institution of Civil Engineers.

Addresses

CROMPTON PARKINSON LIMITED are opening an additional stores and trade counter for batteries, cables, lamps, lighting fittings and small motors at: College Gardens, Edmonton, London N18. (Telephone: EDMonton 7141). The new stores will serve all N., N.E., E. and N.W. Postal Areas, Postal Areas WC1 and EC1, County of Essex and North and North West Middlesex.

THE City of London office of the Export Credits Guarantee Department (the Government department providing United Kingdom exporters with credit insurance against the major financial risks incurred in overseas trading) has been moved to larger premises at Marlon House, Mark Lane, London EC3. (Telephone: Royal 3491).

The ECGD office in Nottingham has moved to new premises at Lloyds Bank Chambers, Old Market Square, Nottingham (Telephone: Nottingham 46585).

THE UNITED STEEL COMPANIES, LIMITED, have decided to set up a central drawing office in London and are equipping premises at 125-127 Victoria Street for this purpose.

SANDVIK SWEDISH STEELS LIMITED, have now moved into their new offices, warehouse and factory at Manor Lane, Halesowen, where there will be a wide

range of Sandvik products and improved product service to users of Sandvik Swedish steels, carbide tipped tools, saws and handtools.

THE name of the Canadian subsidiary of George Kent Limited, Luton, previously Kent-Norlantic Limited, has been changed to George Kent (Canada) Limited, the address for the offices and plant remaining unchanged at 389 Horner Avenue, Toronto 14. The address for Quebec province is George Kent (Canada) Limited, 1176 Sherbrooke Street West, Montreal, and that for British Columbia, George Kent (Canada) Limited, 2760 West Broadway, Vancouver, B.C. The agents for the provinces of Manitoba and Saskatchewan are Mumford, Medland Limited, 576 Wall Street, Winnipeg, and Albert and Fifth Avenue, Regina; and the Maritime Agents, Purves Industrial Sales, 19 Belmont Road, Halifax, Nova Scotia.

THE postal address of the Sheffield district office of Metropolitan-Vickers Electrical Company Limited is now 9 Market Place, Sheffield 1. The telephone numbers Sheffield 23114, 5, 6, 7 and 27848 remain unchanged.

CLARKSON (ENGINEERS) LIMITED, Nuneaton, announce that their Canadian subsidiary, Clarkson Engineering (Canada) Limited, have moved to new premises in Toronto, at 767 Warden Avenue, Scarborough.

THE Birmingham are a sales office of Northern Aluminium Company Limited (Mr. D. W. Taylor, manager), has removed to new premises at Devonshire House, Great Charles Street, Birmingham 3. The telephone number is changed to Central 7393, but the telegraphic address, Noralumin Birmingham, remains the same.

LEVERTON OF LEEDS LIMITED, have removed their entire business from Stanningley to newly erected premises in Gelderd Road, Gildersome, Leeds. Telephone: Morley 4221. Telex No. 55-170. This change has been arranged in readiness for the first output from the new Caterpillar Tractor company's factory in Glasgow. Leverton of Leeds Limited is a subsidiary of H. Leverton & Company Limited, Spalding, Caterpillar and Hyster dealers for the Eastern Counties and parts of the Midlands.

GENERAL DESCALING COMPANY LIMITED of Retford Road, Worksop, have now opened a London sales office at 79/80 Petty France, Westminster, London SW1. Telephone: Abbey 5538.

THE Raw Materials Division of George Cohen Sons & Company Limited, formerly at 191 Corporation Street, Birmingham, is now at Trinity Road, Kingsbury, Tamworth, Staffs.

THE plant sale and hire activities of Chamberlain Industries Limited of Staffa Works, Staffa Road, Leyton, London E10, is to be transferred to Chamberlain Plant Limited, a new company with offices and works at Crown Works, Southbury Road, Enfield, Middlesex.

Tour of Work Study Experts

A team of work study experts from the School of Time and Motion Study Limited is to visit the leading industrial areas to run a week-end "appreciation course" for management in each area. Films, lectures and case studies comprise the background to the course. The school was founded in 1951 and the appreciation courses have been attended by nearly 2000 pupils. The tour starts on September 1 in Scotland.

Film News

Six Hundred Horses.—This new film by Brook Motors Limited production unit runs for 14 min. and shows the production of large electric motors seen through the eyes of the visiting customer. The film covers all the manufacturing processes—winding methods, application of 'cold jointing' for connexions and testing, etc.

Not by Magic.—With a running time of 16 min. this film deals with a number of varied electric motor applications—from lifts to clothing; farming to beer bottling; motor car manufacture to the Emmett Ideal Home.

The company have produced a loose leaf catalogue of their films which may be added to as further films become available. Copies may be obtained free of charge from the Film Division, Brook Motors Limited, Empress Works, Huddersfield.

Survey of Chemical Engineers

THE INSTITUTION OF CHEMICAL ENGINEERS has now summarized the replies received to the questionnaire sent to professors, technical college principals and heads of departments in Great Britain regarding present and future supply of chemical engineers and the difficulties experienced in obtaining suitable teaching staff. By 1966, with adequate support, the country could provide 950 chemical engineers each year—this compares with just under 300 in 1956. Teacher shortage is real and widespread, Industry has helped both directly and indirectly but there is justification for more interest and support particularly in the provision of student apprenticeship schemes and the seconding of qualified men from industry to teach for periods of not less than six months. Further information may be obtained from the general secretary of the Institution, 16 Belgrave Square, London SW1.

Siemens Centenary

THE celebration this year of the centenary of Siemens Brothers & Company Limited, is a tribute to pioneering achievements of William Siemens in the fields of telegraphy, dynamo electric machinery, electric lighting, land and submarine cables, and a new method of making steel. He led the company in all its activities for 25 years and shortly before his death in 1883 received the honour of Knighthood from Queen Victoria. Two years ago the company became a part of Associated Electrical Industries Limited and thus a part of a much larger organization. From this followed last year an amalgamation with another company of the A.E.I. Group—The Edison Swan Electric Company, and its activities are now carried on under the name of Siemens Edison Swan—a resounding combination of pioneering names which must be unique.

Contracts and Work in Progress

BIRLEC LIMITED, Birmingham. New contract for electric furnaces worth approximately £500,000 for the Newport Division of the Steel Company of Wales Limited.

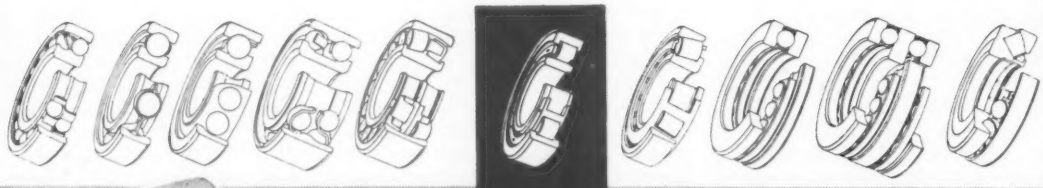
HEENAN & FROUDE LIMITED, Worcester—Order from British European Airways for complete dynamometer plant for testing engines at London Airport.

RUSTYFA LIMITED. (The British consortium company founded last summer for the purpose of supplying plant and equipment for a large tyre factory being built in the Ukraine.) The latest group of orders is worth £5 million. The principal items of plant and equipment will be supplied by David Bridge & Co. Limited, Francis Shaw & Co. Limited, Crompton Parkinson Limited, Lancashire Dynamo Holdings Limited, Mather & Platt Limited, Simon Handling Engineers Limited and Geo. W. King Limited.

THE ENGLISH ELECTRIC EXPORT & Trading Company, London.—Further U.S.A. contract worth some $5\frac{1}{2}$ million for Priest Rapids in the State of Washington, calling for two more water turbine generating sets, each 83,000 kVA at 85.7 rpm.

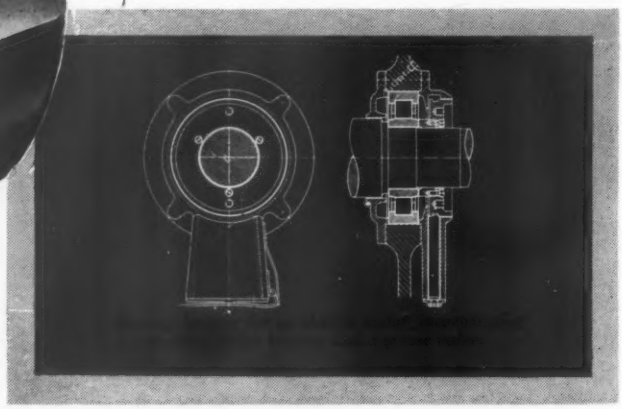
METROPOLITAN - VICKERS ELECTRICAL Company Limited, Manchester.—Contract valued at about £$1\frac{1}{2}$ million covering the construction and equipping of the Gach Saran Power System for the Iranian Oil Exploration and Producing Company. Sub-contractors are Richard Costain Limited and British Insulated Callender's Construction Co. Limited, Consulting engineers: Ewbank & Partners Limited.

Only SKF can offer such a wide selection of British made bearings



Illustrated on the left is the SKF cylindrical roller bearing, one of the ten variants of the four basic types of rolling bearing manufactured in Great Britain by The Skefko Ball Bearing Co. Ltd. The cylindrical roller bearing has a low coefficient of friction and is therefore suitable for shafts operating at high speeds. Because of its high radial carrying capacity it is extensively used in electric motors, gearboxes and similar applications.

Behind every SKF bearing lies unrivalled experience in the design and application of rolling bearings all over the world. This experience is at your disposal from any one of Skefko's twenty Branch Offices, situated at strategic points all over the British Isles.



THE SKEFKO BALL BEARING COMPANY LIMITED · LUTON · BEDS

THE ONLY BRITISH MANUFACTURER OF ALL FOUR BASIC BEARING TYPES: BALL, CYLINDRICAL ROLLER, TAPER ROLLER AND SPHERICAL ROLLER

G170b

Cable Firm's Agreement

ENFIELD CABLES LIMITED have signed an agreement with Federal Wire and Cable Division, H. K. Porter Company (Canada) Limited whereby that organization will market Enfield products in Canada. Provision is also made for the sharing of technical 'know-how' and experience. Enfield's resident engineer in Canada, Mr. J. Morgan-Blades, will remain in his present position and will act as technical adviser to Federal on power cable matters.

Open Days at M.E.R.L.

THE MECHANICAL ENGINEERING RESEARCH Laboratory, East Kilbride, Glasgow, is to hold Open Days on Wednesday, June 4 and Thursday, June 5 1958, when representatives of any organization with engineering interests will be welcome. Applications for invitations, stating which day is preferred, should be sent to the Director.

New Steel Trade Mark

THE Trade Mark 'Fircleve' has been accepted by the Registrar of Trade Marks as applicable to the range of cold rolled steel strip and flattened wire, and cold rolled hardened and tempered steel strip and flattened wire, produced and marketed by Firth Cleveland Steel Strip Limited. The Trade Mark Registration Number is 770,885.

Dewrance New Division

A new division of Dewrance & Company Limited, manufacturers of boiler mountings, etc., to be known as the Jones Tate Division, is to be operated by their subsidiary company Jones, Tate & Company Limited, Victory Works, Bradford, Yorks., under the managership of Mr. P. F. Gifford, successor to Mr. C. E. Jones retired. The division manufactures a wide range of powered, automatic and solenoid operated valves and the sales side, under the managership of Mr. A. C. Jones, A.M.I.Mech.E., will operate from the London office at 165 Great Dover Street, SE1 (Telephone: HOP 3100). Correspondence other than sales should, as formerly, be addressed to Victory Works, Bradford.

Vacancies in Engineering

THE PROFESSIONAL ENGINEERS APPOINTments Bureau Report for 1957 recently published shows that the steady demand for engineers of all grades was maintained during the year, although there was some reduction in the numbers of vacancies notified. Civil engineering offered some interesting and well-paid posts abroad; mechanical and electrical engineering vacancies for design, development and research were based mainly in the United Kingdom. Senior vacancies were mainly managerial or administrative. Full details of the facilities offered may be obtained from the Bureau's offices at 39 Victoria Street, London SW1. (Telephone: Abbey 1737).

Jugoslavian Agents

CAMBRIDGE INSTRUMENT COMPANY LIMITED has appointed as their agents for Jugoslavia, the B.S.E. Company Limited, Heddon House, 149-151 Regent Street, London W1.

Sykes Machine at U.S.A. Exhibition

AT the Philadelphia (U.S.A.) exhibition of the American Society of Tool Engineers, to be held next month, will be shown in action a Sykomatic magazine loading gear genera tor, the first to be shipped overseas by the Staines works of W. E. Sykes Limited. The Sykomatic, while having the advantages of automation, yet occupies only a fraction of the space required by a transfer machine.

Foundry Firm's N. American Division

To ensure quality of service in their export trade to U.S.A. and Canada, Foundry Equipment Limited (Linslade Works, Leighton Buzzard, Bedfordshire) has formed its own North American division under the title F. E. (North America) Limited, of 185 Eileen Avenue, Toronto 9, Canada. The British company has taken extensive show space under the name of their new division at the A.F.S. Foundry Show, Cleveland, Ohio, to be held during May.

Agricultural Machinery Exports

THE export of British agricultural machinery, especially of tractors, continues at a high level and the lead held over Germany during 1956 and 1957 is emphasized by statistics recently published by The Agricultural Engineers Association Limited. The Association is of opinion that partly due to rising costs and prices of German machinery the lead should be maintained throughout 1958. Finland, Germany and Sweden are all expected to increase their imports of British machinery.

Eire Distributors for Continental Compressor

CHAMBERLAIN PLANT LIMITED, temporarily at Staffa Works, Staffa Road, Leyton, London E10, (a subsidiary of Chamberlain Industries Limited of the same address) has been appointed sole distributors for Eire for the Jenbach J.W.78 diesel driven air compressor.

Lifting Gear Joint Company

A NEW joint company formed between Herbert Morris Limited, crane and lifting equipment manufacturers, and Brown, Lenox & Co. (London) Limited, will begin operations this month at Milwall, London E14. The work of the existing lifting gear department of Brown, Lenox will be continued, and the spares and servicing organization for Morris equipment in the area will be taken over.

Construction and Foundry Merger

THE Scunthorpe railway and civil engineering firm of Eagre Construction Company Limited has now acquired the Newport (Mon.) concern, Isca Foundry Company Limited, manufacturers of railway materials and permanent way equipment. Mr. John Spafford is the new chairman and managing director of both concerns. Colonel W. L. C. Phillips, formerly a director of Isca, has been appointed manager, and Mr. J. Thomas (formerly Eagre accountant) secretary. The merger will strengthen the position of the parent company in its business of railway contracting.

GF *Silver Jubilee*

THIS year Britannia Iron and Steel Works Limited, Bedford, celebrates its Silver Jubilee, 25 years during which the company has seen its GF malleable tube fittings become as famous as the earlier imported Swiss pipe fittings +GF+. But the company can look back on a much longer historical association with the iron industry, when just over 100 years ago two brothers, James and Frederick Howard, built the forerunner of the modern Britannia works to manufacture ploughs and other farm implements. An illustrated booklet issued to mark the Jubilee traces the long history and makes interesting reading. The Le Bas Tube Company Limited of 129 Finsbury Pavement, London EC2 are a subsidiary of Britannia Iron and Steel Works, and the sole selling agents for GF pipe fittings in Great Britain and the Commonwealth.

Miraclo Belt in Canada

A NEW Canadian company has been formed, Extremultus Transmissions Limited (115-6th Avenue, Lachine, Quebec), to stock and distribute the Miraclo belt under the name Miraclo-Extremultus. The Miraclo British-made nylon belt is made jointly by Ira Stephens Limited, Ashton-under-Lyne, Lancs., and Stephens Belting Company Limited, Birmingham, by arrangement with Sieglingriemen of Hanover, West Germany, the inventors and manufacturers of this type of transmission belt marketed in Europe, U.S.A. and non-Commonwealth countries under the trade name Extremultus.

RAWLPLUG

DURIUM

Registered Trade Mark

The world's FASTEST masonry drill

DURIUM is the drill that revolutionized masonry drilling, staggering the industrial user with its amazing speed of penetration and sharp, silent, easy-cutting *accuracy!* With its tough, almost diamond-hard Durium tip, and its patented rapid-helix flute to force out spoil and prevent clogging, the Durium Drill penetrates masonry of all kinds at a speed unequalled anywhere in the world.

and the most durable

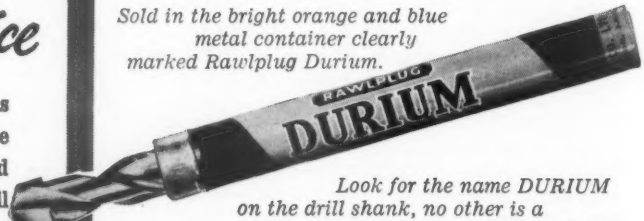
Just as important to your costs is the extraordinary *durability* of Durium Drills. Remember that masonry is an *abrasive* material which quickly ruins ordinary drills. The astonishing *toughness* of the Durium tip, and the stronger backing of steel given it by the specially designed flute, makes Durium Drills the world's most durable masonry drill.

R.P.I. ELECTRIC DRILL This is the ideal power tool for use with Durium Drills. With a full load speed of 450 r.p.m. it combines high torque with a weight of less than 5 lbs.

Free resharpening service

When, at long last, your Durium Drill begins to lose its keenness, return it to us with the complimentary voucher supplied with it, and we'll re-sharpen it FREE! Write now for full details of these fastest-of-all masonry drills.

Sold in the bright orange and blue metal container clearly marked Rawlplug Durium.



Look for the name DURIUM on the drill shank, no other is a genuine DURIUM Drill.

B 589

THE RAWLPLUG COMPANY LTD., CROMWELL ROAD, LONDON, S.W.7

Braking Efficiency

"Braking Efficiency", is the new title of a revised publication issued by Ferodo Limited, Chapel-en-le-Frith, Stockport, which first appeared under the title of "Concerning Brakes".

The new version, which like its predecessors discusses all the principal aspects of defining and measuring braking efficiency and the operation of the Ferodo brake testing meter, has been brought into line with current thought and experience of the problem. Most notable, however, is the section dealing with the minimum braking limit, particularly as it applies to multi-axle vehicles. This has been completely re-written after consultations with the Motor Bus Committee of the Municipal Passenger Transport Association.

Valves for Industrial Services

The multitude of valve designs and fittings illustrated and embodied in a well bound catalogue issued by Cockburns Limited, Cardonald, Glasgow SW1, are backed by nearly a hundred year's experience in this field. Commencing with a brief survey of the firm's production facilities, the main body of catalogue is devoted to safety valves, stop valves and special purpose valves of all descriptions.

Mechanite Castings

The variety of Mechanite castings in regular production at the foundries of Ashmore, Benson, Pease & Company, Stockton-on-Tees, is amply illustrated in a new brochure. Ashmore's were the first foundry to obtain a licence in this country for the production of Mechanite castings. Today they have capacity for castings from 1 lb up to 20 ton in weight.

See Us for Dust

Another booklet, No. 55 with the very appropriate title adopted by Dallow Lambert & Company Limited, Thurmaston, Leicester, has been published. Illustrated pages show examples of their Dustmaster and Drytex Unit dust collectors, Drytube fabric sleeve filters and wet deduster installations in foundries.

Miniature Circuit Breakers

A new range of miniature circuit breakers, Type F-60 in ratings up to 60 amp and for supplies of up to 500 V a.c. has been introduced by J. A. Crabtree & Co. Limited, Lincoln Works, Walsall, Staffs. On the results of independent tests the manufacturers claim that these new circuit breakers have a performance superior to that of any comparable unit produced anywhere in the world.

The operating mechanism and arc chambers of the Type F-60 are separated from the cable terminals and fixing screws. The cover of the mechanism chamber is also sealed against tampering immediately after the unit has been calibrated and tested in the manufacturer's works.

Electronic Batching Counters

Fast counting up to 6000 per min—automatic batching in any number from one to 1000—recording up to 1,000,000, these are the main features of the model 6001 electronic batching counter manufactured by Atkins, Robertson & Whiteford Limited, Industrial Estate, Thornliebank, Glasgow, described in a new leaflet.

The BEAMA Catalogue, Fourth Edition

The fourth edition of the BEAMA Catalogue—the buyers' guide to the products and services of Britain's electrical industry—has been published for The British Electrical & Allied Manufacturers' Association (Incorporated), 36 Kingsway, London WC2, by Iliffe & Sons Limited.

The descriptive pages have been subdivided, each division being printed in a

Trade Literature

distinctive second colour. The divisions are classified under electrical power plant, electrical equipment in industry, transport and communications and domestic and commercial electrical appliances, lighting, accessories and installation material.

Product headings listed in English, French, German, Portuguese and Spanish, provides a comprehensive cross-reference to the technical equivalent terms used in other countries.

The classified buyers' guide lists under more than 1300 headings the comprehensive range of electrical equipment manufactured by BEAMA firms and a trade directory gives the principal addresses of all BEAMA member-firms, and over 4780 names and addresses, grouped territorially, of member firms' overseas branches, representatives and agents. Containing 962 pp and cloth bound the price is £6.

Ferrous Alloys

Over 160 different ferrous alloys and metals are being handled by Union Carbide Limited, Alloys Division, 103 Mount Street, London W1. In their new publication, "Product Sketches" an attempt has been made to detail briefly the grades which are available. They include chromium, silicon, manganese, zirconium, briquetted alloys, boron, calcium, columbium, titanium, tungsten and vanadium.

Malleable Iron Pipe Fittings

An abridged catalogue of GF malleable iron tube fitting for steam ,gas or oil service published by Le Bas Tube Company Limited, Britannia Iron & Steel Works, Bedford, constitutes a valuable reference handbook for all concerned with pipe layouts and systems. In addition to the more common types and sizes of fittings its pages contain a whole host of special bends, tees, unions, and sockets which in the main the makers carry in stock in both black and galvanized finishes.

Oil or Gas Fired Crucible Furnaces

Lip-pouring and central axis tilting crucible furnaces are among the furnace installations described in a leaflet issued by Monometer Manufacturing Company Limited, Savoy House, 115–116 Strand, WC2. These furnaces are designed for all non-ferrous melting and may be oil or gas fired.

Electric Hoists for Loads up to 10 ton

Available in over 200 different types and sizes for loads from 3 cwt up to 10 ton for a wide diversity of applications Clayton electric hoists are shown in leaflet No. 500 B., published by The Clayton Crane & Hoist Company Limited, Irwell Chambers, Union Street, Liverpool 3. Amongst the hoists featured is the Clayton Cadet, a two-speed "hook-on" wire rope hoist for raising 10 cwt loads at 6 and 25 fpm up to a height of 20 ft. This model is intended for hooking on existing trolleys or support girders.

Taper Roller Bearings for Machine Tools

The latest catalogue together with a set of data sheets describing the range of Gamet Micron precision taper roller bearings is now available from Gamet Products Limited, Hythe, Colchester.

These bearings are primarily intended for the machine tool industry, and other applications where extreme bearing accuracy is required.

Flow Indicators

Walker, Crosweller & Co. Limited, of Cheltenham have issued a comprehensive pamphlet illustrating their Arkon flow indicators for cooling water, lubricating oil, gas or air, etc. Incorporated are their latest models (sizes ¼ in. to 1 in.) which can be adjusted for high or low velocities of flow.

Bolts and Nuts—Price List

Coincident with their centenary year Macnays Limited, G.P.O. Box 14, Middlesbrough have issued a loose leaf thumb-indexed catalogue and price list covering bolts, nuts and tube fittings for the general engineering industry.

Carlisle. John Laing and Sons, Dalston Road, have received a contract for additions to premises at Botchergate for Graham and Roberts Limited, automobile engineers.

Chester-le-Street. The Urban District Council has approved plans for central workshops at South Pelaw Colliery for the National Coal Board. The Board's Architects' Department is at 24 The Side, Newcastle-on-Tyne.

Durham. A factory addition covering 4,000 sq. ft is proposed by Towers (Sunderland) Limited, Framwellgate Moor. The firm will use direct labour.

Easington. The Durham Coal Board (No. 3 Area), Castle Eden, are to erect a locomotive shed at Blackhall Colliery.

Felling (Co. Durham). John Dickinson & Company, Hemel Hempstead, are to erect a warehouse at Stoneygate Lane, and and have prepared their own plans.

Gateshead. Hastie D. Burton Limited, King Street, North Shields are the contractors for a factory extension at Team Valley for Smith's Delivery Vehicles Limited. Tenders are being considered for a further extension.

Factory additions are also proposed at Team Valley for the Armstrong Cork Co. Limited. The architects are Cordingley and McIntyre, Owengate, Durham City.

Middlesbrough. Northern Welders, Durham Street, are to erect workshop and offices in Feversham Street. The architect is L. Auton, Regent Buildings, York Road, West Hartlepool.

Shipman Limited propose bakery extensions in Roman Road to plans by Kitching & Company, 21 Albert Road.

S. Hill & Son Limited, bakers, Longlands Road, are to carry out bakery extensions at the rear of Trenholme Road.

Newcastle-on-Tyne. L. G. Mouchel and Partners, 24 Claremont Road, have been appointed consulting engineers by the City Council for large extensions to Newcastle Quay.

Plans have been approved for factory additions in Westmorland Road for Tyne Textiles Limited. The architect is Maurice Gatoff, 26 Mosley Street.

North Shields. The Tyne Improvement Commission, Berwick Street, Newcastle-on-Tyne are making borings at Northumberland Dock, where it is proposed to construct a deep-water berth to serve a new oil distribution depot planned by the Esso Petroleum Company Limited, London. Work on the new quay may begin in the autumn. The Commission's chief engineer is R. B. Porter.

Sunderland. Plans have been approved for the erection of offices at Pallion Engine Works for W. Doxford and Sons Limited. The contractors are Brims & Company, City Road, Newcastle-on-Tyne.

Newrick and Blackbell, 58 John Street, Sunderland have prepared plans for alterations to Hendon Paper Works, Ocean Road.

G. T. Brown and Son, 53 Fawcett Street, are the architects for laundry additions in Ryhope Road for Luxdon Laundry, and workshops and showrooms in Roker Avenue for Byers Garages Limited.

Wolsingham (Co. Durham). Office additions are proposed for Wolsingham Steelworks. The architects are Marshall and Tweedy, 36 Blackett Street, Newcastle-on-Tyne.

Birmingham. The Midland Radiator Company (Birmingham) Limited, 232 Aston Road, are to erect a new factory in Great Lister Street.

Bolton. Extensions are to be made to Albion Works, Waterloo Street, for B. & F. Carter & Company Limited.

Bury. Extensions are to be made to the Premier Mills for E. W. Andrew Limited, Walshaw Road.

Buxton. The factory of Brake Linings Limited, in Bridge Street is to be extended.

Chesterfield. A new workshop is to be built off Derby Road for H. Camm & Company Limited, Central Drive, Wingerworth.

Dundee. Extensions are to be made to the factory of Vidor Limited.

Holo-Krome Limited are to make extensions to their factory.

Edmonton. The British Tap & Die Company Limited, Town Road, London N9 is to build a new factory on the Claverings industrial estate.

Enfield. The architects for extensions to the factory of Gor-Ray Limited, 758 Great Cambridge Road are Aslan & Freeman, 90 Lower Thames Street, London EC4.

Gosport. Extensions are to be made to the factory of E. S. Perry Limited, Farnham Road, Bridgemary.

Guildford. M. H. Brashier, 11 Gayfere Street, Westminster, London SW1, is the architect for the new factory to be erected for Keefe & Lewis Limited, Rodborough Buildings, Bridge Street.

Glasgow. K. L. McKenzie & Partners Limited, 80 Charles Street, London N1, are to erect a new factory at Cadder Road.

New Factories

Harmondsworth. The contracts for extensions to the works of Norman Hay Limited, electro-chemical engineers, Bath Street has been let to W. S. Try Limited, Cowley, Uxbridge.

Hayes. The architects for extensions to the works of Callard & Bowser Limited, Silverdale Works are Huckle & Durkin, 30 Queen Anne Street, London W1.

C. E. Wilford & Son, 2 Green Street, London W1, are the architects for extensions to the works of Tercrete Limited, Rigby Lane, Dawley Road.

Leominster. Contractor Switchgear Limited, Moorfield Road, Wolverhampton, are to erect a new factory.

Llansamlet. A new ferrous sulphate plant is to be erected at the Swansea Vale Works of the Imperial Smelting Corporation Limited.

London. A new factory is to be built at Ormside Street, London SE15, for John Dukes Limited, the architects are Austin, Vernon & Partners, 5 Buckingham Place, London SW1.

Nottingham. Wolsey Limited, Kimberley, are to modernise their spinning plant.

Penrith. Gush & Dent Limited, engineers, New Farm Road, Alresford are considering the erection of a new factory at Castletown.

Peterborough. Extensions are to be made to the factory at Fengate for Root Harvesters Limited.

Plymouth. The factory of Bush Radio Limited, Ernsettle industrial estate is to be extended.

Radcliffe. The East Lancashire Paper Mill Company Limited, are to replan their Mount Sion Works.

St. Leonards-on-Sea. Extensions are to be made to Woodlands Works, The Ridge, for Central Engineering Works (Hastings) Limited.

Stretford. A new saw and planing mill is to be built at Trafford Park Road for Parkers (Ancoats) Limited, Little Newton Street, Manchester.

Southend-on-Sea. Merx Optical Company Limited, 45 Hatton Garden, London EC1, are to build a new factory on the Sutton Road industrial estate.

A new factory and offices are to be erected for Eden Fisher Holdings Limited, 6 Clements Lane, London EC4.

Stalybridge. The Bankwood Mills, Park Street, are to be rebuilt (after fire) for the Stalybridge Rubber Company Limited.

Stoke Newington. Extensions are to be made to the factory at 72a Palatine Road for Worthy Products Limited.

Sutton Coldfield. Erdington Jig & Tool Company Limited, have applied for permission for extensions to the factory and offices on the Reddicap trading estate.

Walsall. The Perfect Finish Flooring Company, Lower Green Lane, are to build a new factory at Garden Street.

Watford. The factory of Austin & Company (Containers) Limited, Cole King's, Hagden Lane, is to be extended.

Wellingborough. F. Holt, Northern Assurance Chambers, 5 Tithe Barn Street, Liverpool, is the architect for extensions to the printing works at Sheep Street for Perkins & Company (Wellingborough) Limited.

West Bromwich. Extensions are to be made to the factory of George Salter Limited.

Phoenix Steel Tube Company Limited, Phoenix Street, are to make extensions to their works.

Dundee. National Cash Register Limited, are to make further extensions to their plant which will necessitate employing at least another 120 persons.

Timex Limited are to extend their Craigie factory by 5,400 sq ft.

North East Scotland. The Scottish Council (Development and Industry) have inquiries from six American companies interested in Scottish sites. One U.S. machine tools concern will employ 1000 workers in a factory to be located in north-east area of Scotland. The Scottish Council is investigating other sites at Glenrothes and in other parts of the country.

Glenrothes. Beckman Instruments are to open shortly at Glenrothes, Fife, producing a range of scientific instruments.

Anderson, Boyes and Company Limited, of Motherwell, are also to occupy a factory here manufacturing coal mining equipment.

Inverurie. British Railways are installing new white-metalling plant to metal bearings in engine axle boxes, replacing older outdated plant.

Uddingston. Caterpillar Tractor Company Limited are nearing completion of their 600,000 sq ft one floor factory at Tannochside for the production of earth moving and mechanical handling equipment.

Imperial Chemical Industries Limited propose to establish a unit in Northern Ireland for the spinning of Terylene polyester fibre. Production may begin in 1963 or 4, and the project will eventually require at least 2,000 employees.

Northern Aluminium Company Limited plans to spend £10 million over the next four years, nearly £8 million of this being for new plant and building. The aluminium rolling mill at Rogerstone, Monmouthshire will be expanded to raise its annual capacity to 75,000 tons and ultimately to 175,000 tons, and modernization of the Banbury and Birmingham works will also be effected.

Classified Advertisements

Advertisements are inserted at the rate of 2/9d. per line, and should be sent to

31 King Street West, Manchester 3.

Situations Vacant

WANTED—Author to write practical course on Electrical Maintenance and Repairs for leading Correspondence College. Write in first instance giving outline of experience and qualifications to Box VW 7, "Mechanical World", 31 King Street West, Manchester 3.

Machinery, Plant and Accessories For Sale

SEDWICK 200-TONS DOUBLE GEARED PRESS BRAKE for sale. Capacity 12 ft × ¼ in. Motor drive with controls. Depth of gap 18 in. Stroke 3 in. Die space with stroke down and bed in lowest position 4⅛ in. Between side frames 83 in. Top tool 18⅜ in. deep. Weight about 15 tons. Illustrations, etc., from F. J. Edwards Ltd., 359 Euston Road, London NW1 or 41 Water Street, Birmingham 3.

"FRIGIDAIRE" Low Temperature Refrigerators. 49 in.w × 28 in.d × 34 in.h ext. Ex Large National User, suitable A.C. or D.C. Deep Freezing, Storage of Ice Cream, Frozen Foods, etc. Price £40.0.0 each. Domestic Refrigerators, Service Cabinets and Cold Rooms also available. A.R.C. 134 Great Portland Street, London W1. MUSeum 4480.

PUMPS for all purposes. R. L. Christiansen Limited, Wordesley, Stourbridge. Brierley Hill 7584.

UNUSED 'COLLIS' PORTABLE ELEVATING TRUCKS, 30-cwt capacity. Makers model No. B.4/7. £25 each. UNUSED 'COLLIS' PORTABLE ELEVATING TRUCKS, 50-cwt capacity. Makers model No. MS/6/10. £55 each. TWO 'Yale' Red Streak Hand Lift Trucks, 3500-lb capacity. £25 each. Full details on request to: Thos. W. Ward Limited, Albion Works, Sheffield. Tel: 26311. Ext. 305.

APPROX. 5000-ft OF PRACTICALLY UNUSED GRAVITY ROLLER CONVEYOR FOR DISPOSAL, ROLLERS 14 in., 18 in. wide, rollers 2½ in. dia., set at 4 in. and 6 in. pitch, set in angle iron frames, complete with hooks and trunnion pins for coupling up, together with Bends, and Stands. Details from Thos. W. Ward Limited, Albion Works, Sheffield. Tel: 26311. Ext. 305.

Machinery, Plant and Accessories Wanted

BALL and roller bearings, etc. Wanted! Also surplus goods—especially hand tools—of all descriptions. For Sale: Metal boxes of strong and sturdy gauge and construction with handles in all sizes. Ask for details. R. Pordes, 138 New Cavendish Street, London W1, MUSeum 5250.

Patents for Sale or License

THE proprietor of British Patent No. 709069 is prepared to sell the patent or to license British manufacturers to work thereunder. It relates to "Improvements in the Driving Mechanism of Winches". Address: Boult, Wade & Tennant, 112 Hatton Garden, London EC1.

THE proprietor of British Patent No. 631412, entitled "Clamp", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 East Jackson Boulevard, Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 663229, entitled "Improvements in Weighing Machine", offers same for license or otherwise to ensure its practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, Chrysler Building, New York 17, New York, U.S.A.

THE proprietor of British Patent No. 685422, entitled "Improvements in Variable Speed Wire Spray Gun", offers same for license or otherwise to ensure its practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, Chrysler Building, New York 17, New York, U.S.A.

THE proprietor of British Patent No. 718976, entitled "Improvements in or Relating to Couplings for Rods, Tubes and the like", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 East Jackson Boulevard, Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 684356, entitled "Machine and Method for Stripping Hop Vines", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 East Jackson Boulevard, Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 664335, entitled "Spring Plunger", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 East Jackson Boulevard, Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 701630, entitled "Gang Apparatus for Tightening a Plurality of Threaded Fastening Elements", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 East Jackson Boulevard, Chicago 4, Illinois, U.S.A.